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PART II:

DEPARTMENT OF TRANSPORTATION

Coast Guard

■

SELF-PROPELLED VESSELS CARRYING BULK LIQUEFIED GASES

Proposed Standards

DEPARTMENT OF TRANSPORTATION

Coast Guard

[46 CFR Parts 31, 34, 54, 98, 154]

[CGD 74-289]

SELF-PROPELLED VESSELS CARRYING BULK LIQUEFIED GASES

Proposed Standards

• *Purpose.* The Coast Guard is considering adding, to the rules concerned with tank vessels, design, inspection, construction, equipment, and operating requirements for self-propelled vessels carrying bulk liquefied gases. •

Written Comments

Interested persons may participate in this rule making procedure by submitting written data, views, or arguments on the proposal contained in this document to the Executive Secretary, Marine Safety Council (G-CMC/81), Room 8117, U.S. Coast Guard, Washington, D.C. 20590. Each person submitting written comments should identify this notice (CGD 74-289), any specific wording recommended, reasons for any recommended change, and the name, address, and organization, if appropriate, of the commenter. Copies of the comments received will be available for examination by interested persons in Room 8117, Coast Guard Headquarters, Washington, D.C.

Public Hearing

The Coast Guard will hold a public hearing on November 15, 1976, beginning at 0900 in Room 2232, 400 Seventh Street, SW., Washington, D.C. Interested persons are invited to attend the hearing and present oral or written statements on this proposal. It is requested that anyone desiring to make oral comments at the hearing notify the Executive Secretary, Marine Safety Council (G-CMC/81), Room 8117, U.S. Coast Guard, Washington, D.C. 20590, at least 10 days before the scheduled date of the public hearing and specify the approximate length of time needed for the presentation. It is urged that a written summary or copy of the oral presentation be included with the request.

Closing Date for Comments

All comments received before December 15, 1976, will be fully considered and evaluated before final action is taken on the proposal in this document. These proposed regulations may be changed in light of the comments received.

Discussion of Proposal

Currently, design, construction, inspection and operating requirements for self-propelled vessels carrying bulk liquefied gases are contained in Subchapters D, I, and O of Title 46, Code of Federal Regulations. These regulations contain the standards that a U.S. vessel must meet for the issuance of a certificate of inspection, and the standards that a foreign vessel's cargo containment and transfer systems and related systems must meet for the issuance of a Letter of Compliance.

In 1971, the Coast Guard made a request to the Chemical Transportation Industry Advisory Committee (CTIAC) to review these existing regulations and to prepare a recommendation for the development of international standards for gas ships. This advisory group to the Commmandant consisted of representatives of the American Bureau of Shipping, the American Petroleum Institute, the Shipbuilders Council of America, the Manufacturing Chemists Association, the Society of Naval Architects and Marine Engineers, the Compressed Gas Association, and the American Gas Association.

During the same year, the Inter-Governmental Maritime Consultative Organization (IMCO) recognized the need for a code for liquefied gases carried in bulk. An ad hoc working group on bulk chemicals, under the Subcommittee on Design and Equipment of IMCO's Maritime Safety Committee, undertook the development of this code in 1972. Representatives of the Coast Guard and CTIAC were part of the ad hoc working group. By 1975, the Code for Construction and Equipment of Ships Carrying Liquified Gases in Bulk (the Code) was completed and adopted by Assembly Resolution A.328 (IX) (November 1975).

The proposed regulations in this document correspond to the Code. As in the Code, they would apply to the following self propelled new vessels that have on board bulk liquefied gases as a cargo, cargo residue, or vapor:

1. A vessel that is constructed under a building contract awarded after October 31, 1976.

2. In the absence of a building contract, a vessel that has the keel laid or is at a similar stage of construction after December 31, 1976.

3. A vessel that is delivered after June 30, 1980.

4. A vessel that has undergone a major conversion for which—

a. The building contract is awarded after October 31, 1976;

b. In the absence of a building contract, conversion is begun after December 31, 1976; or

c. Conversion is completed after June 30, 1980.

The proposed regulations for new vessels include definitions and requirements for vessel stability, cargo tank location, vessel arrangements, cargo containment systems, piping systems, materials of construction, cargo pressure and temperature control, cargo venting systems, filling limits for cargo tanks, evnironmental control in and around cargo tanks, fire protection, ventilation in the cargo area, instrumentation, crew protection, operating the vessel, and special carriage for particular gases. Implementation of the IMCO recommendations is necessary because the Code defers some matters to the discretion of each administration, and in other matters is not specific enough for Coast Guard regulatory purposes. The major changes from the Code are discussed in the following paragraphs.

"Liquefied gas" is changed from the Code's definition of "a product having a vapor pressure of 2.8 kp/cm² at 37.8° C" to the proposed definition of "a product having a vapor pressure of 1.76 kp/cm² at 37.8° C." This is a change in the definition from a Reid vapor pressure of 40 psia to 25 psia. The change in the Reid vapor pressure includes the "certain other substances" referred to in § 1.2 of the Code, but does not include any product in IMCO's Chemical Code except ethylamine, which is presently listed in the Code and the Chemical Code. The change in the Reid vapor pressure was proposed by the U.S. delegation to IMCO but the change was not adopted, although there was apparently no objection to it. The change, however, does not affect the list of regulated cargoes.

The rate of air change between the airlock doors is not specified in the Code (§ 3.6.1) but is proposed at 12 changes per hour.

It is proposed that leaked cargo from interbarrier spaces be pumped to an emergency dump. It is proposed as an alternative to the Code requirement that leaked cargo be returned to the cargo tanks.

Chapter 4 of the Code includes a provision for the evaluation of the insulation and hull steel assuming for the purpose of design calculations that the cargo tank and secondary barrier, if installed, are at the design temperature and the ambient outside air and sea design temperatures as follows:

General Worldwide

Still Air: +5° C (41° F)
Sea Water: 0° C (32° F)

Chapter 4 also provides that each administration may set higher or lower ambient design temperatures. This document proposes the following temperatures:

Any Waters in the World, except Alaskan Waters

Air (at 5 knots): —18° C (0° F)
Still sea water: 0° C (32° F)

Alaskan Waters

Air (at 5 knots): —29° C (—20° F)
Still sea water: —2° C (28° F)

The proposed regulations specify enhanced grades of steel for crack arresting purposes in the deck stringer, sheer strake, and bilge strake. The minimum acceptable grade for the deck stringer and the sheer strake is Grade E or an equivalent steel that is specially approved by the Commandant (G-MMT). The minimum acceptable grades for the bilge strake are Grade D or Grade E or an equivalent steel that is specially approved by the Commandant (G-MMT).

The proposed allowable stresses for membrane, semi-membrane, and independent tank type A is the same as the allowable stresses for these tanks in the Code. However, for independent tank types B and C, stress factors are not the same at the stress factor for these tanks in the Code.

In the Code, the stress factors listed for independent tank types B and C are

the minimum factors that may be used in calculations. The stress factors proposed in these regulations meet Section VIII of the ASME Code, 1974, are greater than the minimum listed in the Code, and must be used in independent tank type B and C calculations for vessels to which the regulations apply.

The Code allows pressure and temperature control of cargoes by venting cargo vapors to the atmosphere when the vessel is at sea and in port if accepted "by the receiving administration". It is proposed to prohibit normal venting of cargo vapor into the atmosphere in a U.S. port.

The Code requires the cargo system to be designed to withstand the full vapor pressure of the cargo under conditions of the upper ambient design temperature or have other means to maintain the cargo tank pressure below the maximum allowable relief valve setting (MARVS) of the tank. These regulations propose that when the cargo carried is a liquefied gas, the cargo tank pressure must be maintained below the design vapor pressure indefinitely, the pressure on a LNG tank would be maintained below the design pressure for a period of not less than 21 days. Cargo tank pressure may be maintained below the design pressure by several methods including refrigeration systems, burning boil-off gas in waste heat or catalytic furnaces, using boil-off gas as fuel, or a combination of these methods. Using the boil-off gas as a fuel for propulsion is limited to a vessel carrying LNG.

The proposed regulations also include the following:

1. Transfer requirements for vinyl chloride.
2. Loading requirements for methyl acetylene-propadiene mixture.
3. Additional operating requirements.
4. Requirements for inspection and reinspection of U.S. flag vessels at intervals that are the same as for vessels inspected under Subchapter D. Inspection for certification would be required every 2 years and reinspection would be required between the 10th and 14th month following issuance of a Certificate of Inspection.
5. Requirements for the initial and periodic inspections and tests of the cargo containment system, cargo and process piping, and hull heating and cold spots.

The following table contains a list of the proposed regulations and their source from the Code:

IMCO code:	*Proposed regulations or explanation of no regulation*
Ch. I	154.1 through 154.12.
1.1	154.1.
1.2.1	154.3(tt).
1.2.2(a)(i)	154.1(a).
1.2.2(a)(ii)	154.1(b).
1.2.2(a)(iii)	154.1(c).
1.2.2(a)(iv)	154.1 (d) and (e).
1.2.2(b)	Only applicable to code.
1.2.3	Do.
1.2.4	Do.
1.3	Information only.
1.4	154.3.
1.4.1	Information, included in 154.3 (q) and (oo).
1.4.2	154.3(qq).
1.4.3	154.3(d).
1.4.4	154.3(r).
1.4.5	154.3(pp).
1.4.6	154.3(f).
1.4.7	154.3(g).
1.4.8	154.3(ll).
1.4.9	154.3(ff).
1.4.10	154.3(gg).
1.4.11	154.3(u).
1.4.12	154.3(y).
1.4.13	154.3(x).
1.4.14	154.3(rr).
1.4.15	154.3(j).
1.4.16	154.3(s).
1.4.16(a)	154.3(s)(1).
1.4.16(b)	154.3(s)(2).
1.4.16(c)	154.3(s)(3).
1.4.16(d)(i)	154.3(s)(4).
1.4.16(d)(ii)	154.3(s)(5).
1.4.16(e)	154.3(s)(6).
1.4.16(f)	154.3(s)(7).
1.4.16(g)	154.3(s)(8).
1.4.16(h)	154.3(s)(9).
1.4.16(i)	154.3(s)(10).
1.4.16(j)	154.3(s)(11).
1.4.16(k)	154.3(s) (12).
1.4.16(l)	154.3(s)(13).
1.4.17	154.3(t).
1.4.18	154.3(mm).
1.4.19	154.3(nn).
1.4.20	154.3(b).
1.4.21	154.3(ii).
1.4.22	154.3(h).
1.4.23	154.3(m).
1.4.24	In existing 46 CFR 30.10–56.
1.4.25	154.3(aa).
1.4.26	154.3(e).
1.4.27	154.3(ee).
1.4.28	154.3(ss).
1.4.29	154.3(a).
1.4.30	154.3(cc).
1.4.31	Information only.
1.4.32	Do.
1.4.33	Do.
1.4.34	154.3(q).
1.4.35	154.3(oo).
1.5.1	154.8 (a), (b), and (c).
1.5.2	Only applicable to code.
1.6.1(a)	154.40 through 154.122.
1.6.1(b)	154.130 through 154.142.
1.6.1(c)	Do.
1.6.2	154.6.
1.6.3	154.6
1.6.4	154.6(b).
1.6.5	154.6(b).
1.6.6	Only applicable to code.
1.6.7	154.6.
1.6.8	154.6.
1.6.9	154.6.
1.6.10	154.6.
1.7.1	Only applicable to code.
1.7.2	Do.
1.7.3	Do.
Ch. II	154.200 through 154.235.
2.1.1	154.200.
2.1.2	154.210.
2.1.3	154.215.
2.1.4	Only applicable to code.
2.2.1	154.205.
2.2.2	154.205.
2.2.3	154.1809.
2.3	154.220(d).
2.3.1	154.225.
2.3.2	154.220.
2.3.2(a)(i)	154.220(1)(i).
2.3.2(a)(ii)	154.220(1)(ii).
2.3.2(a)(iii)	154.220(1)(iii).
2.3.2(b)(i)	154.220(2)(i).
2.3.2(b)(ii)	154.220(2)(ii).
2.3.2(b)(iii)	154.220(2)(iii).
2.3.2(c)	154.220(b).
2.4.1	154.230.
2.4.1(a)(i)	154.230(b).
2.4.1(a)(ii)	154.230(a).
2.4.1(a)(iii)	154.230(c).
2.4.1(b)(i)	154.230 (a) and (c).
2.4.1(b)(ii)	154.1455.
2.4.1(b)(iii)	154.1020.
2.4.2	154.230(d).
2.4.3	154.230(g).
2.4.4	154.230(h).
2.5	154.210.
2.5.1	154.215(a).
2.5.2(a)	154.215(b)(1).
2.5.2(b)	154.215 (b)(2) and (c).
2.5.3(a)	154.215(d)(1).
2.5.3(b)	154.215(d)(2).
2.5.4	154.215(e).
2.6.1(a)	154.235(a).
2.6.1(b)	154.235(b).
2.6.2	154.235(c).
2.6.3	154.235(d).
2.6.4	Information only.
2.7.1	Do.
2.7.2	Do.
Ch. III	154.300 through 154.355.
3.1	154.300.
3.1.1	154.300(a).
3.1.2	154.300(b).
3.1.3	154.300(c).
3.1.4(a)	154.305(a).
3.1.4(b)	154.305(b).
3.1.5(a)	154.310(a).
3.1.5(b)	154.310(b).
3.1.5(c)	154.310.
3.1.5(d)	154.310.
3.1.5(e)	154.310(f).
3.1.6	Information only.
3.2.1	154.325 (a) and (b).
3.2.2	Information only.
3.2.3	Do.
3.2.4	154.330 (a), (b), and (c).
3.2.5	154.330(d).
3.2.6	154.330(e).
3.3.1	154.315(a).
3.3.2	154.315(b).
3.3.3	154.340.
3.4.1	154.320(a).
3.4.1(a)	154.320(b)(1).
3.4.1(b)	154.320(b)(2).
3.4.2	154.320 (b)(3) and (c).
3.4.3	Information only.
3.5.1	154.132(a)(8), 154.136(e), 154.140, and 154.340(f).
3.5.2	154.132(a)(9) and 154.340 (g).
3.5.3	154.340(b).
3.5.3(a)(i)	154.340(a).
3.5.3(a)(ii)	154.340(b).
3.5.3(a)(iii)	154.340(c).
3.5.3(b)	Information only.
3.5.3(c)	Do.
3.5.4	154.340(e).
3.6.1	154.345 (a) and (b)(1).
3.6.2	154.345(b)(2).
3.6.3	154.345(b)(3).
3.6.4	154.345(c).
3.6.5	154.345(b) (4) and (5).
3.6.6	154.345(b)(7).
3.6.7	Information only.
3.7.1(a)	154.350 (a) and (b).
3.7.1(b)	154.350 (a) and (b).
3.7.2	154.350(c).
3.7.3	154.350(d).
3.8.1	Information only.
3.8.2	154.355(a) (1), (2), (3), and (4) and 154.1870 (a).
3.8.3	154.355(a) (5) and (6) and 154.1870(b).
3.8.4	154.355(b) and 154.1870 (c).
3.8.5	154.1110(c), 154.1145(a) (2), and 154.1150.
Ch. IV	154.401 through 154.476.
4.1	Information only.
4.2.1(a)	154.3(2).
4.2.1(b)	154.419.
4.2.1(c)	154.418.
4.2.2(a)	154.3(dd).
4.2.2(b)	154.426.
4.2.2(c)	154.425.
4.2.3(a)	154.3(hh).

IMCO code:	*Proposed regulations or explanation of no regulation*
4.2.3(b)	154.436.
4.2.4	154.3(w).
4.2.4(a)	154.437 and 154.438.
4.2.4(b)	154.445.
4.2.4(c)	154.451 and 154.453.
4.2.5	154.3(o).
4.2.5(a)	154.405(b).
4.2.5(b)	154.405(a).
4.2.5(c)	154.405(c).
4.2.6	154.3(n).
4.3.1(a)	154.406(a).
4.3.1(b)	154.406(c).
4.3.1(c)	154.406(a) (10) and (11).
4.3.1(d)	154.406(b).
EEE	
4.3.2(a)	154.407(a).
4.3.2(b)	154.407(b).
4.3.3	154.408.
4.3.4(a)	154.409(a).
4.3.4(b)	154.409(c).
4.3.4(c)	154.409(d).
4.3.4(d)	154.409(e).
4.3.4(e)	Information only.
4.3.4(f)	154.409(f).
4.3.5(a)	154.410(a).
4.3.5(b)	154.410(b).
4.3.6(a)	154.411(a).
4.3.6(b)	154.411(b).
4.3.7	154.470.
4.4.1	154.420 (a) and (b).
4.4.2(a)	154.427(a).
4.4.2(b)	154.430 and 154.431.
4.4.2(c)	154.429(b).
4.4.2(d)	154.427(c).
4.4.2(e)	154.188, 154.427(d), 154.428, and 154.429(b).
4.4.3	154.435.
4.4.4(a)	154.439 (a) and (b) and 154.440(c).
4.4.4(b)	154.439(b) (2).
4.4.5(a)	154.444 and 154.448 (e) and (f).
4.4.5(b)	154.448(b).
4.4.5(c)	154.448(c).
4.4.5(d)	154.448(d).
4.4.5(e)	154.449.
4.4.5(f)	154.448(g).
4.4.6(a) (i)	154.450.
4.4.6(a) (ii)	154.450.
4.4.6(a) (iii)	154.104.
4.4.6(b) (i)	154.450.
4.4.6(b) (ii)	154.452.
4.4.6(c) (i)	154.450.
4.4.6(c) (ii)	154.450(a).
4.4.6(c) (iii)	154.450.
4.4.6(d)	154.450(b).
4.4.6(e)	154.450(c).
4.5.1(a)	154.421.
4.5.1(b)	154.428.
4.5.1(c)	154.440.
4.5.1(d) (i)	154.447(a).
4.5.1(d) (ii)	154.447(b).
4.5.1(e)	154.450.
4.5.1(f) (i)	154.401 and 154.630 (b) and (c).
4.5.1(f) (ii)	App. A.
4.5.1(f) (iii)	Do.
4.5.1(g) (i)	154.630(a).
4.5.1(g) (ii)	154.409(b).
4.5.2(a)	154.412 (a) and (b).
4.5.2(b)	154.412.
4.6.1	154.470(a) (1) and (2).
4.6.2	154.471(a) (1) and (2).
4.6.3	154.471(a) (4).
4.6.4	154.471(a) (3).
4.6.5	154.471(b).
4.6.6	154.470(b).
4.6.7	154.470(c).
4.7.1	154.459(a).
4.7.2(a)	154.449(d) (1).
4.7.2(b)	154.459(d) (2).
4.7.3	154.459 (a) and (e).
4.7.4(a)	154.460(a).
4.7.4(b)	154.460(b).
4.7.4(c)	154.460(c).
4.7.5	154.460.
4.7.6(a)	154.460.
4.7.6(b)	154.460.
4.7.7	154.136(j).
4.8.1	154.465 and 154.466(a).
4.8.2	154.466(b).
4.8.3	154.174 and 154.176.
4.8.4	Do.
4.8.4(a)	154.178(a).
4.8.4(b)	154.178(b).
4.8.4(c)	154.178.
4.8.4(d)	154.178(c).
4.8.5	Information only.
4.9.1	154.170 (a) and (d).
4.9.2	154.615 and 154.620.
4.9.3	154.615.
4.9.4	154.172.
4.9.5	154.466(c).
4.9.6	154.466(d).
4.9.7	154.467(a) (1) through (14).
4.9.8	154.467(a) (15).
4.9.9	154.466(e).
4.10.1(a)	154.650(c) (1) and (2).
41.0(b) (i)	154.650(d).
4.10.1(b) (ii)	154.650(d).
4.10.2	Information only.
4.10.3	154.650(e).
4.10.4	154.50 and 154.650(f).
4.10.5	154.50.
4.10.6	154.52.
4.10.7(a)	154.102(a) and 154.104(a).
4.10.7(b) (i)	154.102 (b), (c), and (d).
4.10.7(b) (ii)	154.104 (b), (c), and (d).
4.10.8(a)	154.54.
4.10.8(b)	154.56.
4.10.8(c) (i)	154.58(a) (1).
4.10.8(c) (ii)	154.58(a) (2).
4.10.8(c) (iii)	154.58(a) (3).
4.10.8(c) (iv)	154.58(b).
4.10.8(c) (v)	Information only.
4.10.8(c) (vi)	154.60.
4.10.8(c) (vii)	154.58(c) (1) and (2).
4.10.9	154.60.
4.10.10	154.62.
4.10.11	154.64.
4.10.12	154.110.
4.10.13	154.120.
4.10.14	154.122.
4.10.15	154.450.
4.11(a)	154.655 and 154.655(b).
4.11(b) (i)	154.655(a).
4.11(b) (ii)	154.655(a).
4.11.(b) (iii)	154.655(a).
4.11.(b) (iv)	154.655(a).
4.12(a)	154.409(c) (2) (i).
4.12(b)	154.409(c) (2) (ii).
4.12(c)	154.409(c) (2) (iii).
4.12(d) (i)	154.409(c).
4.12(d) (ii)	154.409(c).
4.13	App. B.
Ch. V	154.500 through 154.562.
5.1.1	Information only.
5.1.2	Do.
5.2.1(a)	154.500.
5.2.1(b)	154.503, 154.506, and 154.508(a).
5.2.2	154.512 and 154.516.
5.2.3	154.514.
5.2.4	154.517.
5.2.5	154.519.
5.2.6(a)	154.500.
5.2.6(b) (i)	154.500.
5.2.6(b) (ii)	154.500.
5.2.6(c)	154.500.
5.2.6(d) (i)	154.500.
5.2.6(d) (ii)	154.500.
5.2.6(e)	154.500.
5.2.7	154.520.
5.2.8(a)	154.522(a) (1) and (2).
5.2.8(b)	154.522(b).
5.2.9(a)	154.66 (a) and (b).
5.2.9(b)	154.68(a).
5.2.9(b) (i)	154.68(a) (2).
5.2.9(b) (ii)	154.68(a) (3).
5.2.9(b) (iii)	154.68(a) (1).
5.2.9(b) (iv)	154.68(a) (4).
5.2.9(b) (v)	Information only.
5.2.10(a)	Do.
5.2.10(b) (i)	154.524(a) (1), (2), and (3).
5.2.10(b) (ii)	154.524(b).
5.2.10(b) (iii)	154.524(c).
5.2.10(c) (i)	154.523(a).
5.2.10(c) (ii) (1)	154.526 and 154.523(c).
5.2.10(c) (ii) (2)	154.526 and 154.528(b).
5.2.10(d)	Information only.
5.2.10(e) (i)	154.508(b).
5.2.10(e) (ii)	154.508(a).
5.2.10(f) (i)	154.660(a).
5.2.10(f) (ii)	154.660(b).
5.2.10(f) (iii) (1)	154.660(c) (1).
5.2.10(f) (iii) (2)	154.660(c) (3).
5.2.11(a)	154.70.
5.2.11(b) (i)	154.70 (a), (b), and (c).
5.2.11(b) (ii)	154.72.
5.2.11(c)	154.74.
5.3.1(a)	154.530 (a) and (b).
5.3.1(b)	154.532 (a), (b), and (c).
5.3.1(c)	154.534.
5.3.2	154.536.
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5.5.1	154.476(a).
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6.1.2	Only applicable to code.
6.1.3	Information only.
6.1.4(a)	154.605(a).
6.1.4(b)	154.605(b).
6.1.5	Information only.
6.1.6	Do.
6.1.7	Do.
6.1.8	Do
6.1.9	154.172(a).
6.2	Only applicable to code.
Table 6.1	154.610 (a) through (g).
Table 6.2	Amended 46 CFR 54.25–10 and 154.615.
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Table 6.4	154.625
Table 6.5	154.172
6.3.1	154.650(a).
6.3.2	154.650(b).
6.3.3	154.665.
6.3.3(a)	154.665.
6.3.3(b) (i)	154.665.
6.6.6(b) (ii)	154.665.
6.3.3(b) (iii)	154.665.
6.3.3(b) (iv)	154.665.
6.3.4(a)	154.665.
6.3.4(b)	154.665.
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6.3.6(a)	154.76, 154.78, and 154.84.
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6.3.6(b) (ii)	154.80(c).
6.3.6(c)	154.82.
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6.3.7(a) (i)	154.94(a) and 154.96.
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7.1.1	154.701(a).
7.1.1(a)	154.701(a)(1) and 154.703 (b) and (c).
7.1.1(b)	154.701(a).
7.1.1(c)	154.701(a)(2).
7.1.1(d)	Information only.
7.1.1(e)	154.1836.
7.1.2	154.701(a)(2) and 154.702(a)(1).
7.1.3	Information only.
7.2.1	154.702(a)(1).
7.2.2(a)	154.701(b).
7.2.2(b)	154.701(b).
7.2.3	154.702(d).
7.2.4(a)	154.1735 and 154.1750.
7.2.4(b)	154.1720.
7.2.4(c)	154.1735 and 154.1750.
7.2.5	154.702(e).
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8.1	Information only.
8.2.1	154.801 (a) and (b).
8.2.2	154.912.
8.2.3	154.801(c)(2).
8.2.4	154.801(c)(4) and (5).
8.2.5	154.66 (a) and (b), 154.801(c)(1) and (3), and 154.1846.
8.2.6(a)	154.802(a).
8.2.6(b)	154.802(b).
8.2.7	154.1846.
8.2.8(a)	154.801(c)(8)(i).
8.2.8(b)	154.801(c)(8)(ii).
8.2.8(c)	154.801(c)(8)(iii).
8.2.9	154.801(c)(6) and 154.805 (a), (b), and (d).
8.2.10	154.805 (e) and (f).
8.2.11	Information only.
8.2.12	154.801(c)(7).
8.2.13	154.805 (f) and (g).
8.2.14	154.805(c).
8.2.15	Information only.
8.2.16	154.801(c)(6).
8.2.17	154.801(c)(5).
8.3.1 and 8.3.2	None — unnecessary alternative requirements.
8.4.1	154.804(c).
8.4.2(a)	154.804(a)(1).
8.4.2(b)	154.804(a)(2) (i) and (ii).
8.4.2(c)	Information only.
8.4.3	154.804(a)(2)(iii).
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9.4.4	154.904(a).
9.4.5	154.904 (b) and (c) and 154.912.
9.5.1	154.906.
9.5.2	154.904 (a), (b), and (c).
9.5.3	154.908 (a) and 154.910.
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10.1.4	Do.
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10.2.4	154.1010 (e) and (f).
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10.2.4(c)	154.1010(f)(6).
10.2.4(d)	154.1010(e)(3), (4), and (5) and (f)(3), (4), and (5).
10.2.4(e)	154.1010(f)(7).
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10.2.5(b)	154.315(b).
10.2.5(c)	Information only.
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10.2.6	154.1010(j).
10.2.6(a)	154.1010(j)(1).
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11.2.2	154.1100.
11.2.3	Amended 46 CFR 34.10-15.
11.2.4	154.1100.
11.2.5	154.1100.
11.3.1	154.1105.
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11.3.1(b)	154.1110(b).
11.3.1(c)	1554.1110 (c) and (d).
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11.3.2	154.1115 and 154.1130 (a) and (b).
11.3.3	154.1125(c) and 154.1135.
11.3.4	154.1135(a)(3).
11.3.5	154.1125(d).
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11.4.2	154.1145 and 154.1150 (a) and (b).
11.4.3	154.1145 (a)(1) and (c), 154.1150 (c), (d), and (e), and 154.1165 (a) and (b).
11.4.4	154.11565(c).
11.4.5	154.1170.
11.4.6	154.1145(b), 154.1155, and 154.1160.
11.4.7	154.1145(a)(2) and 154.1150 (a), (d), and (e).
11.5.1	Existing 46 CFR.
11.5.2	Do.
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11.6.2	Do.
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12.1.1	154.1200 (a) and (b), 154.1205(f), and 154.1850.
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13.1.2	154.1325(b), 154.1335(a)(2), and 154.1340(b).
13.1.3	Information only.
13.2.1	154.1305.
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13.2.2(a)	Information only.
13.2.2(b)	Do.
13.2.2(c)	154.1310.
13.2.2(d)	154.1315.
13.2.3	154.1320(a).
13.2.4	154.1320 (b) and (c).
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13.4.3	154.1335(e).
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13.5.3(a)	154.1340(d).
13.5.3(b)	154.1340(e).
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13.6.1	154.1345 (a) and (b).
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13.6.7(c)	154.1350(a)(3).
13.6.7(d)	154.1350(a)(4).
13.6.7(e)	154.1350(a)(5).
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13.6.7(g)	154.1350(a)(6).
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13.6.13	154.1345 (a)(2) and (b)(1).
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14.4	Do.
14.5	154.1400 (a)(2) and (b)(2) and 154.1415.
14.6	154.1430.
14.7	154.1852.
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14.9	154.1425, 154.1435, and 154.1440.
Ch. XV	None—requirements located in other sections.
15.1.1	154.1844(a)(1).
15.1.2	154.1844(a)(2).
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15.1.4	None—unnecessary alternative requirements.
15.2	154.1810.
Ch. XVI	None—requirements located in other sections.
16.1	154.703.
16.2	154.706(a).
16.2(a)	154.706(a)(1).
16.2(b)	154.706(a)(2).
16.3	154.1854(b).
16.4	154.706(b).
16.5	154.707.
16.6	154.708 (a) and (b).
16.7	154.708(c).
16.8	154.705(b).
16.9	154.706(a)(2) and 154.707(b).
16.10	154.709.
16.11	Information only.
16.12	Do.
Ch. XVII	154.1700 through 154.1755.
17.1	Only applicable to code.
17.2.1	154.1405 (a) and (b).

IMCO code:	*Proposed regulations or explanation of no regulation*
17.2.2	154.1410 (a) and (b).
17.2.3	154.1400(c).
17.2.4	Information only.
17.2.5	Do.
17.3	154.1700.
17.4	154.1705.
17.5	154.1720, 154.1725, 154.1735, and 154.1750.
17.6	154.660(c)(2).
17.7	154.355(a)(2) and 154.1870(d).
17.8	154.1710.
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17.11.1	154.1345(d).
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17.12.1	154.1725 and 154.1730.
17.12.1(a)	154.1725(a)(1).
17.12.1(b)	154.1730(a)(2).
17.12.1(c)	154.1730(b).
17.12.1(d)	154.1725(c).
17.12.1(e)	154.1725(d).
17.12.1(f)	154.1725(e).
17.12.1(g)	154.1725(a) (2) and (3).
17.12.1(h)	154.1730(a).
17.12.2	154.1735.
17.12.3	154.1755.
17.12.4	154.1010.
17.12.5	Information only.
17.12.6	154.1740, 154.1745, and 154.1750.
Ch. XVIII	154.1800 through 154.1868.
18.1.1	154.1810 and 154.1814.
18.1.2	154.1818.
18.2	154.1820 and 154.1832.
18.3	Information only.
18.4	154.1850.
18.5	154.1810 and 154.1856.
18.6	154.1840.
18.7	154.1842.
18.8	154.1812, 154.1814, and 154.1822.
18.9	Only applicable to code.
Ch. XIX	Table 4.
Appendix	Standard Coast Guard form to be printed.

AMENDMENTS TO SUBCHAPTERS D AND F

Since Subchapters D and F are applicable to self propelled vessels that carry bulk liquefied gases, amendments are being proposed that would update those subchapters to conform to the Code.

LETTERS OF COMPLIANCE

An objective that the Coast Guard hoped to attain in the development of the Code was to terminate the plan review portion of the Letter of Compliance program for new foreign flag vessels.

The Code is substantially sufficient to ensure the Coast Guard that a new foreign flag gas vessel entering U.S. ports has been designed to the necessary standards. Therefore, the Coast Guard proposes that a new foreign flag vessel meet the proposed regulations or have an IMCO Certificate of Fitness, in addition to meeting the following design requirements in the proposed regulations, which differ from the Code:

1. Allowable stress in § 154.447 and § 154.450.
2. Crack arresting steels in § 154.170.
3. Ambient design temperatures in § 154.466.
4. Cargo temperature and pressure control in § 154.701 through § 154.709.

If the vessel has an IMCO Certificate of Fitness the Coast Guard would not require plan review. The Certificate of Fitness must be issued by or on behalf of the flag administration, and must have all information required in the Model Form of Certificate of Fitness for the Carriage of Liquefied Gases in Bulk, which is published in the Appendix to the Code. It is proposed to require submission of a copy of the Certificate of Fitness to the Coast Guard before the vessel arrives in a U.S. port.

It is also proposed that in addition to the IMCO Certificate of Fitness, the following plans and information, in English, must be submitted to the Coast Guard before a vessel arrives in a U.S. port with a bulk liquefied gas cargo. These plans and information would be retained in the Coast Guard's files for use during vessel examinations and in any emergency that the vessel may encounter while in a U.S. port:

1. Description of the vessel.
2. Specifications for the cargo containment system.
3. General arrangement of the vessel.
4. Midship section of the vessel.
5. Schematic plans of the liquid and vapor cargo piping.
6. Firefighting and safety plan.

A foreign flag vessel is examined at its first U.S. port of call under 46 CFR Part 154. A 2 week notification to the Coast Guard of the vessel's arrival at the first U.S. port of call is also required. The information for the notification must include the following:

1. The first part of call.
2. The cargoes carried.
3. The estimated arrival date.
4. The vessel's agent.
5. The berthing facilities for the vessel.

It is proposed that the following information, in English, be carried on board these foreign flag vessels for Coast Guard use during examinations:

1. A description and schematic plan of the arrangement for inerting cargo tanks, hold spaces, and interbarrier spaces.
2. A description of the tank gauging equipment.
3. A description and instruction manual for the calibration of the cargo leak detector equipment.
4. A schematic plan that shows the locations of leak detectors and sampling points.
5. A description of the systems for cargo temperature and pressure control for methane to meet proposed § 154.701 through § 154.709.

If the proposed regulations are adopted by the Coast Guard, there will be many gas vessels that do not have Letters of Compliance and cannot receive IMCO Certificates of Fitness as new vessels. Included in this group are 120 ships now under review by the Coast Guard for Letters of Compliance. Each gas vessel that has applied for a Letter of Compliance since March 11, 1975, has been required by the Coast Guard to meet the Code. Vessels that are under construction, but applied for a Letter of Compliance before March 11, 1975, are being required by the Coast Guard to meet the Code insofar as it is possible, taking into consideration the stage of each vessel's construction.

Existing foreign flag gas vessels (i.e., foreign flag vessels that are not new foreign flag gas vessels) that are now in service and have never undergone plan review for a Letter of Compliance will have to comply with the standards of the Letter of Compliance program in effect at the time of their construction, as well as any additional requirements that may be established by future regulations concerned with existing gas vessels.

Existing U.S. gas vessels (i.e., U.S. vessels that are not new U.S. gas vessels) would continue to meet the requirements in Subchapters D and I as well as any additional requirements established by future regulation concerned with existing ships.

The Coast Guard has determined that the proposed regulations would have no foreseeable significant impact on the quality of the human environment. An environmental assessment with a negative declaration has been prepared. Copies may be obtained in Room 8117, Coast Guard Headquarters, Washington, D.C. 20590.

The Coast Guard has determined that this proposal is not a major proposal in accordance with Department of Transportation Policies to Improve Analysis and Review of Regulations—Regulatory Reform, as published in the April 16, 1976 issue of the FEDERAL REGISTER (41 FR 16200) and DOT Order 2050.4 dated February 2, 1976. Therefore, an economic evaluation and a negative declaration of inflationary impact are required.

The economic evaluation for this proposal shows that for each of the next seven fiscal years the proposed regulations would result in the following:

(a) A decreased expenditure of about $0.2 million by the Federal government, and no significant impact on state and local governments.

(b) An increase cost of $21.6 million to consumers businesses and industry.

(c) No significant impact on energy consumption, important materials or employment.

The benefits to the public of the proposal include:

(1) A consolidation of design and equipment regulations for various liquefied gas ships in one part.

(2) Incorporation of an internationally agreed standard for liquefied gas ships with clarification, where possible, of portions of that standard (the IMCO Gas Code) that are left to the "satisfaction of the Administration." This phrase is used often in the IMCO Gas Code, and, in the case of the U.S., refers to the U.S. Coast Guard.

(3) Codification of existing and additional requirements for the design, construction, and operation of liquefied gas ships.

A quantitative analysis of benefit to the public is difficult to assess due to the excellent safety record of liquefied gas ships. However, it is clear that the adoption of an international standard that further increases the level of safety of gas ships is beneficial to the public in-

terest. U.S. gas ship owners and operators will benefit in having an internationally accepted Certificate to facilitate their vessels' operation in foreign ports.

Copies of the economic evaluation and negative declaration of inflationary impact are available upon request to the Executive Secretary (G-CMC/81), Coast Guard Headquarters, Washington, D.C. 20590.

The close cooperation with the Chemical Transportation Industry Advisory Committee, the acceptance of an international code containing similar provisions, and the fact that many liquefied gas ships throughout the world and in the United States are already being built to these standards ensures their technological and economic feasibility.

In consideration of the foregoing, it is proposed to amend Chapter I of Title 46, Code of Federal Regulations, as follows:

PART 31—INSPECTION AND CERTIFICATION

1. By amending Part 31 by adding § 31.10–18a to read as follows:

§ 31.10–18a Liquefied gas vessels: Additional firefighting equipment inspections.

(a) Once during each 12 month period after the month an original certificate of inspection is issued for a liquefied gas vessel under § 31.05–1, the master shall ensure that the firefighting systems required in Part 154 of this chapter for a liquefied gas vessel meets the following:

(1) The exterior water spray system must pass a water spray test.

(2) The dry chemical system must meet the manufacturer's specifications for—

(i) The amount of dry chemical powder; and

(ii) The pressure for nitrogen bottles.

(3) The piping, valves, and controls of the system must be operable.

(b) On the date that the requirements under paragraph (a) are met, the master shall record in the vessel's official logbook the following information:

(1) The date of the inspection.

(2) The identification of each device inspected.

(3) The name of the inspector.

PART 34—FIREFIGHTING EQUIPMENT

§ 34.10–15 [Amended]

2. By amending § 34.10–15 as follows:

a. In paragraph (b), by adding after the word "piping" the words ", except on self propelled vessels carrying bulk liquefied gases that must have stop valves—

(1) At cross connections;

(2) At the front of the after deck house; and

(3) In the cargo area spaced 40 m (131 ft.) or less between hydrants."

b. In paragraph (e), by adding after the word "approximately" the words "71 pounds per square inch on self propelled vessels that carry bulk liquefied gases and approximately", and by adding after "50 pounds per square inch" the words "on other tankships".

PART 40—SPECIAL CONSTRUCTION, ARRANGEMENT, AND OTHER PROVISIONS FOR CARRYING CERTAIN FLAMMABLE OR COMBUSTIBLE DANGEROUS CARGOES IN BULK

Subpart 40.05—[Revoked]

3. By revoking Subpart 40.05.

PART 54—PRESSURE VESSELS

4. By amending § 54.15–25 by revising paragraph (c) and adding paragraph (c–1) to follow paragraph (c) to read as follows:

§ 54.15–25 Minimum relief capacities for cargo tanks containing compressed or liquefied gas.

* * * * *

(c) The rate of discharge for heat input of fire must meet the following formula:

$$Q = FGA^{0.82}$$

Where:

Q = Minimum required rate of discharge in cubic meters (cubic feet) per minute of air at standard conditions of 0° C and 1.03 kp/cm² (60° F and 14.7 psia).

F = Fire exposure factor for the following tank types:

F = 1.0 for tanks without insulation located on the open deck.

F = 0.5 for tanks on the open deck having insulation that has approved fire proofing, thermal conductance, and stability under fire exposure.

F = 0.5 for uninsulated independent tanks installed in holds.

F = 0.2 for insulated independent tanks in holds or for uninsulated independent tanks in insulated holds.

F = 0.1 for insulated independent tanks in inerted holds or for uninsulated independent tanks in inerted, insulated holds.

F = 0.1 for membrane and semi-membrane tanks.

G = Gas factor of:

$$G = \frac{177}{LC}\sqrt{\frac{ZT}{M}} \left(G = \frac{633{,}000}{LC}\sqrt{\frac{ZT}{M}} \right)$$

Where:

L = Latent heat of the material being vaporized at relieving conditions, in Kcal/kg (Btu per pound).

C = Constant based on relation of specific heats (k) Table § 54.14–25(c) (if k is not known C = .606 (315) is used).

Z = Compressibility factor of the gas at relieving conditions (if not known, Z = 1.0 is used).

T = Temperature in degrees K = (273+ degrees C) (R = (460+ degrees F)) at the relieving conditions (120% of the pressure at which the pressure relief valve is set).

M = Molecular weight of the product.

A = External surface area of the tank in m² (sq. ft.) for the following tank types:

For a tank of a body of revolution shape:

A = External surface area.

For a tank other than a body of revolution shape.

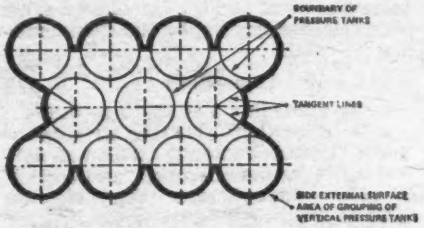
A = External surface area less the projected bottom surface area.

For a grouping of pressure vessel tanks having insulation on the vessel's structure:

A = External surface area of the hold without the projected bottom area.

For a grouping of pressure tanks having insulation on the tank:

A = External surface area of the pressure tanks excluding insulation, and without the projected bottom area.[1]



SIDE EXTERNAL SURFACE AREA OF GROUPING OF VERTICAL PRESSURE TANKS

Figure 54.15–25 (c)

TABLE 54.15–25(c).—*Constant C*

k	C
1.00	.606 (315)
1.02	.611 (318)
1.04	.615 (320)
1.06	.620 (322)
1.08	.624 (324)
1.10	.628 (327)
1.12	.633 (329)
1.14	.637 (331)
1.16	.641 (333)
1.18	.645 (335)
1.20	.649 (337)
1.22	.652 (339)
1.24	.656 (341)
1.26	.660 (343)
1.28	.664 (345)
1.30	.667 (347)
1.32	.671 (349)
1.34	.674 (351)
1.36	.677 (352)
1.38	.681 (354)
1.40	.685 (356)
1.42	.688 (358)
1.44	.691 (359)
1.46	.695 (361)
1.48	.698 (363)
1.50	.701 (364)
1.52	.704 (366)
1.54	.707 (368)
1.56	.710 (369)
1.58	.713 (371)
1.60	.716 (372)
1.62	.719 (374)
1.64	.722 (376)
1.66	.725 (377)
1.68	.728 (379)
1.70	.731 (380)
1.72	.734 (382)
1.74	.736 (383)
1.76	.739 (384)
1.78	.742 (386)
1.80	.745 (387)
1.82	.747 (388)
1.84	.750 (390)
1.86	.752 (391)
1.88	.755 (392)
1.90	.758 (394)
1.92	.760 (395)
1.94	.763 (397)
1.96	.765 (398)
1.98	.767 (399)
2.00	.770 (400)
2.02	.772 (401)
2.20	.792 (412)

[1] Figure 54.15–25(c) shows a method of determining the side external surface area of a grouping of vertical pressure tanks.

(c–1) For an independent tank that has a portion of the tank protruding above the open deck, the fire exposure factor must be calculated for the surface area above the deck and the surface area below the deck, and the calculation must be specially approved by the Commandant (G–MMT).

§ 54.25–10 [Amended]

5. By amending § 54.25–10 as follows:

a. In paragraph (a)(1), by striking the words "in Subchapter D (tank vessels)" and inserting the reference "and § 154.3" in place thereof after the reference "§ 38.05–4".

b. In paragraph (b)(1)(i) by striking "—70° F" and inserting "—67° F" in place thereof.

c. In table 54.25–10(b)(1) in the column entitled "Minimum service[1] temperature °F", by striking "—70" and inserting "—67" in place thereof, and in the column entitled "Manganese range[1] percent" by striking "0.90" and inserting "0.70" in place thereof, and by striking "1.65" and inserting "1.60" in place thereof,

d. By striking the columns following footnote 1 of Table 54.25–10(b)(1) and inserting the following two columns in place thereof:

	Range percent
Si	0.10–5.50
	Maximum
S	0.35
P	.35
Ni	.80
Cr	.25
Mo	.08
Cu	.35
Nb	.05
V	.08

e. In paragraph (b)(2), by striking "—70° F" and inserting "—67° F" in place thereof.

6. By striking in the second sentence in § 56.50–105(a) the words "Subchapter D (Tank Vessels) and I (Cargo and Miscellaneous Vessels)" and inserting "Subchapters D, I, and O" in place thereof.

PART 98—SPECIAL CONSTRUCTION, ARRANGEMENT, AND OTHER PROVISIONS FOR CERTAIN DANGEROUS CARGOES IN BULK

Subpart 98.25—[Revoked]

7. By revoking Subpart 98.25.

8. By redesignating Part 154—Special Interim Regulations for Issuance of Letters of Compliance as an appendix to Subchapter O.

9. By adding a new Part 154 to read as follows:

PART 154—SAFETY STANDARDS FOR SELF PROPELLED VESSELS CARRYING BULK LIQUEFIED GASES

Subpart A—General

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154.1 Applicability.
154.3 Definitions.
154.4 U.S. Flag Vessel Endorsement Application.
154.5 Foreign Flag Vessel Endorsement Application.
154.6 U.S. Flag Certificate Endorsement.
154.8 Equivalents.
154.10 Conflict in regulations.

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154.52 Membrane or semi-membrane tanks: Pressure test.
154.54 Independent tank type A: Pressure test.
154.56 Independent tank type B: Pressure test.
154.58 Independent tank type C: Pressure test.
154.60 Cargo tanks: Weld tightness test.
154.62 Secondary barrier: Weld tightness test.
154.64 Independent tanks type B: Stress level test.
154.66 Cargo and process piping valves: Tightness test.
154.68 Expansion bellows: Cycles and pressure tests.
154.70 Cargo and process piping systems: Hydrostatic test.
154.72 Cargo and process piping systems: Leak test.
154.74 Cargo and process piping systems: Functional test.
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154.78 Membrane tank: Production weld test.
154.80 Semi-membrane tank; independent tank type A or B: Production weld test.
154.82 Independent tank type C and process pressure vessel: Production weld test.
154.84 Secondary barrier: Production weld test.
154.90 Integral tank: Weld inspection standards.
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154.94 Independent tank type A; semi-membrane tank: Weld inspection standards for shell plating.
154.96 Independent tank type B: Weld inspection standards for shell plating.
154.98 Radiographic inspection standards for welds.
150.100 Semi-membrane tank; independent tank type A or B: Additional weld inspection standards.
154.102 Independent tank type C: Weld inspection standards.
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Appendix A—Equivalent Stress
Appendix B—Stress analyses definitions.

AUTHORITY: Regulations for dangerous cargoes issued under R.S. 4472, as amended (46 U.S.C. 170) except those for flammable and combustible liquids issued under sec. 201, 86 Stat. 427, as amended (46 U.S.C. 391a); the functions, powers, and duties relating to the Coast Guard under R.S. 4472, as amended, transfered to the Department under sec. 6(b)(1), 80 Stat. 937 (49 U.S.C. 1655(b)(1)); 46 U.S.C. 170 delegated to the Coast Guard under 49 CFR 1.46 (b) and (t), 46 U.S.C. 391a delegated to the Coast Guard under 49 CFR 1.46(n)(4).

Subpart A—General

§ 154.1 Applicability.

The regulations in this part apply to a self-propelled vessel that has on board bulk liquefied gases as a cargo, cargo residue, or vapor and that—

(a) Is constructed under a building contract awarded after October 31, 1976;

(b) In the absence of a building contract, has the keel laid or is at a similar stage of construction after December 31, 1976;

(c) Is delivered after June 30, 1980; or

(d) Has undergone a major conversion for which—

(1) The building contract is awarded after October 31, 1976;

(2) In the absence of a building contract, conversion is begun after December 31, 1976; or

(3) Conversion is completed after June 30, 1980.

§ 154.3 Definitions.

As used in this part:

(a) "'A' Class Division" means a division as defined in Regulation 3 of Chapter II–2 of the 1974 Safety Convention.

(b) "Accommodation spaces" means public spaces, corridors, lavatories, cabins, offices, hospitals, cinemas, games and hobbies rooms, pantries containing no cooking appliances, and similar spaces. Public spaces are those portions of the accommodations that are used as halls, dining rooms, lounges, and similar permanently enclosed spaces.

(c) [Reserved]

(d) "Boiling point" means the temperature at which a cargo exhibits a vapor pressure equal to the atmospheric barometric pressure.

(e) "Breadth (B)" means the maximum width of the vessel in meters measured admidships to the moulded line of the frame in a ship with a metal shell and to the outer surface of the hull in a ship with a shell of any other material.

(f) "Cargo area" means that part of the ship which contains the cargo containment system and includes the deck areas over the full beam and length of the ship above the foregoing. The cofferdams, ballast or void spaces at the after end of the aftermost hold space or the forward end of the forwardmost hold space are excluded from the cargo area.

(g) "Cargo containment system" means the arrangement for containment of cargo including a primary and secondary barrier, associated insulation and any intervening spaces, and adjacent structure if necessary for the support of these elements. If the secondary barrier is part of the hull structure it may be a boundary of the hold space.

(h) "Cargo service space" means a space within the cargo area used for work shops, lockers, and store rooms of more than 2 m^2 (21.8 $ft.^2$) in area.

(i) [Reserved]

(j) "Cofferdam" means the isolating space between two adjacent steel bulkheads or decks. This space may be a void space or ballast space.

(k) "Commandant" means the Commandant of the Coast Guard.

(l) "Contiguous hull structure" means hull srtucture that includes the inner bottom plating, longitudinal bulkhead plating, transverse bulkhead plating, floors, webs, stringers, and attached stiffeners.

(m) "Control space" means those spaces in which the vessel's radio or main navigating equipment or the emergency source of power is located or where the fire control equipment is centralized.

(n) "Design temperature" means the minimum temperature at which cargo may be loaded, unloaded, or carried.

(o) "Design vapor pressure (P_o)" means the maximum gauge pressure at the top of tank used in the design of the tank.

(p) "Essential auxiliary" means a piece of equipment or system that is vital to the safe operation of the vessel.

(q) "Flammable cargoes" means the following liquefied gases from Table I:

Acetaldehyde	Methane (LNG)
Butadiene	Methyl acetylene-propadiene mixture
Butane	
Butylene	
Dimethylamine	Methyl bromide
Ethane	Methyl chloride
Ethylamine	Propane
Ethyl chloride	Propeylene
Ethylene	Vinyl chloride
Ethylene oxide	

(r) "Flammable range" means the range between the minimum and maximum concentrations of vapor in air which form a flammable mixture.

(s) "Gas-dangerous space" means:

(1) A space in the cargo area that does not have approved arrangements to ensure that its atmosphere is at all times maintained in a safe condition.

(2) An enclosed space outside the cargo area through which any piping that may contain liquid or gaseous cargo passes, or within which such piping terminates, unless it has approved arrangements are installed to prevent any escape of gas into the atmosphere of that space.

(3) A cargo containment system and cargo piping.

(4) A hold space.

(5) A space separated from the hold space defined in paragraph (u) of this section by a single gastight steel boundary.

(6) A cargo pumproom and a cargo compressor room.

(7) A zone on the open deck, or semi-enclosed space on the open deck, within 3 m (10 ft.) of any cargo tank outlet, gas or vapor outlet, cargo pipe flange, cargo valve, or of entrances and ventilation openings to a cargo pump room and cargo compressor room.

(8) The open deck over the cargo area and 3m (10 ft.) forward and aft of the cargo area on the open deck up to a height of 2.4 m (8 ft.) above the weather deck.

(9) A zone within 2.4 m (8 ft.) of the outer surface of a cargo containment system where the surface is exposed to the weather.

(10) An enclosed or semi-enclosed space in which there are lines containing cargo except gas sampling lines led to gas detection equipment under § 154.1350(m) or a space that uses boil-off gas as fuel and complies with § 154.703.

(11) A space for cargo hoses.

(12) An enclosed or semi-enclosed space having a direct opening into any gas-dangerous space or zone, as defined in subparagraphs (1) through (11) of this paragraph.

(t) "Gas-safe space" means a space that is not a gas-dangerous space.

(u) "Hold space" means the space enclosed by the vessel's structure in which there is a cargo containment system.

(v) [Reserved]

(w) "Independent tank" means a self supporting tank that is not a part of the ship's hull and is not essential to the hull strength.

(x) "Insulation space" means a space that may or may not be an interbarrier space, occupied wholly or in part by insulation.

(y) "Interbarrier space" means the space between a primary and a secondary barrier, whether or not completely or partially occupied by insulation or other material.

(z) "Integral tank" means a tank that forms a structural part of the vessel's hull and is influenced in the same manner and by the same loads that stress the adjacent hull structure.

(aa) "Length (L)" means ninety-six percent of the total length in meters on a waterline at eighty-five percent of the least molded depth measured from the top of the keel, or the length from the foreside of the stem to the axis of the rudder stock on that waterline, whichever is greater. In vessels designed with a rake of keel the waterline on which this length is measured must be parallel to the designed waterline.

(bb) "Marine Inspector" means any person designated for the performance of duties with respect to the enforcement and administration of Title 52. R.S.,

acts amendatory thereof or supplemental thereto, rules and regulations thereunder, and the inspections required thereby.

(cc) "MARVS" means the Maximum Allowable Relief Valve Setting of a cargo tank.

(dd) "Membrane tank" means a tank that is non-self-supporting and consists of a thin layer (membrane) supported through insulation by the adjacent hull structure.

(ee) "Permeability of a space" means the ratio of the volume within that space that is assumed to be occupied by water to the total volume of the space.

(ff) "Primary barrier" means the inner element designed to contain the cargo when the cargo containment system included two boundaries.

(gg) "Secondary barrier" means the liquid resisting outer element of a cargo containment system designed to afford containment of any envisioned leakage of liquid cargo through the primary barrier for 15 days and to prevent the lowering of the temperature of the ship's structure to an unsafe level.

(hh) "Semi-membrane" tank means a tank that is non-self supporting in the loaded condition and consists of flat surfaces supported through insulation by the adjacent hull structure, and of shaped corners that connect the flat surfaces that can expand and contract due to thermal, hydrostatic, and pressure loadings.

(ii) "Service space" means a space outside the cargo area used for a galley, pantry containing cooking appliances, locker or store room, workshop other than those forming part of the machinery spaces, and similar spaces and trunks to such spaces.

(jj) "Shut off valve" means a valve that fully closes a pipeline and provides nominal metal to metal contact between the valve operating parts, including the disc and gate, and the valve body.

(kk) "Specific gravity" means the ratio of the density of the cargo, at the lowest temperature at which it may be carried, to the density of water at 4° C (39° F).

(ll) "Tank" means the liquid tight shell designed to be the primary container of the cargo and includes all such containers whether or not associated with insulation or secondary barriers.

(mm) "Tank cover" means the protective structure intended to protect the cargo containment system against damage where it protrudes through the weather deck and to ensure the continuity and integrity of the deck structure.

(nn) "Tank dome" means the upward extension of a portion of the cargo tank. For below deck cargo containment systems the tank dome protrudes through the weather deck or through a tank cover.

(oo) "Toxic cargoes" means the following liquefied gases from Table 4:

Acetaldehyde	Ethylene oxide
Ammonia	Methyl bromide
Dimethylamine	Methyl chloride
Ethylamine	Sulfur dioxide
Ethyl chloride	Vinyl chloride

(pp) "Vapor density" means the relative weight of the vapor compared with the weight of an equal volume of dry air at standard conditions of temperature and pressure.

(qq) "Vapor pressure" means the absolute equilibrium pressure of the saturated vapor above the liquid expressed in kp/cm² (psia) at a specified temperature.

(rr) "Void space" means an enclosed space in the cargo area external to a cargo containment system, which is not a hold space, ballast space, fuel oil tank, cargo pump or compressor room, or any space used by personnel.

(ss) "1974 Safety Convention" means the International Convention on Safety of Life at Sea, 1974.

(tt) "Liquefied gas" means a cargo having a vapor pressure of 1.76 kp/cm² (25 psia) or more at 37.8° C (103° F).

(uu) "Recognized classification society" means a non-government association that has issued standards accepted by the Commandant.

§ 154.4 U.S. flag vessel endorsement application.

(a) A person who desires the endorsement required by § 154.6 for a U.S. flag vessel must submit an application described in § 91.55–15 of this chapter for an endorsement of the vessel's subchapter D Certificate of Inspection.

(b) The person requesting an endorsement under paragraph (a) of this section must submit to the Coast Guard when requested—

(1) Hull type calculations required by § 154.201;

(2) The plans and information listed in §§ 54.01–18, 56.01–10, 91.55–5 (a), (b), (d), (g), and (h); and 111.05–5(d) of this chapter; and

(3) Any other vessel information, such as plans, design calculations, test results, certificates, and manufacturer's data, that the Coast Guard needs to determine whether or not the vessel meets the standards of this part.

§ 154.5 Foreign flag vessel endorsement application.

(a) A person who desires an endorsement on the Letter of Compliance required by § 154.1802 for a foreign flag vessel must submit an application to the Commandant (G–MHM) that includes—

(1) A list of cargoes for which the endorsement is requested;

(2) The names of the U.S. ports in which the person anticipates operating the vessel;

(3) The vessel's country of registry;

(4) A copy of the Certificate of Fitness for the Carriage of Liquefied Gases in Bulk issued under the IMCO Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk, if the vessel holds such a certificate;

(5) The name of the society that classes the vessel;

(6) A brief description of the vessel's cargo containment systems;

(7) Plans, calculations, or other information to show compliance under §§ 154.170, 154.447, 154.450, 154.466, and 154.701 through 154.709; and

(8) The following plans and information:

(i) Description of the vessel.

(ii) Specifications for the cargo containment system.

(iii) General arrangement of the vessel.

(iv) Midship section of the vessel.

(v) Schematic plans of the liquid and vapor cargo piping.

(vi) Firefighting and safety plan.

(b) All correspondence and vessel information must be in English.

(c) If the vessel does not have a Certificate of Fitness issued under the IMCO Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk, adopted without amendments on November 12, 1975 by Assembly Resolution A.328(IX), the plans, calculations and information required by § 154.4(b) must be submitted to the Commandant (G–MHM).

§ 154.6 U.S. flag certificate endorsement.

(a) The Certificate of Inspction for a vessel intended to carry any liquefied gas is endorsed for each individual cargo as follows:

Inspected and approved for the carriage of (enter the applicable cargo name) at a maximum allowable relief valve setting of _____ kp/cm² (_____ psig) with an F factor of _____, a maximum external pressure of _____ kp/cm² (_____ psig), a minimum service temperature of ____ °C (____ °F), and a maximum specific gravity of _____. Hull type _____

(b) The Commandant (G–MVI) also issues an IMCO Certificate of Fitness showing compliance with the IMCO Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk, Resolution A.328(ix), if requested by the vessel owner or operator.

§ 154.8 Equivalents.

(a) Where a vessel must have a particular fitting, material, appliance, apparatus, equipment, provision, procedure, or arrangement, including cargo segregation, the Commandant may accept any other fitting, material, appliance, apparatus, equipment, provision, procedure, or arrangement, that he determines to be as effective as that specified in this part.

(b) In any case where it is shown to the satisfaction of the Commandant (G–MMT) that the use of any particular equipment, apparatus, or arrangement not specifically required by statute, but prescribed by regulations is unreasonable or impracticable, the Commandant (G–MMT) may allow the use of alternate equipment, apparatus, or arrangement to such an extent and upon such conditions as will insure a degree of safety consistent with the minimum standards set forth in this part.

(c) Operational methods or procedures must not be substituted for a particular fitting, material, appliance, apparatus, item of equipment, or type thereof specified in this part.

§ 154.10 Conflict in regulations.

(a) When a specific requirement in another part of this schapter is in conflict with any requirement in this part, the regulations in this part take precedence.

(b) When a vessel carries cargoes regulated by this part and by another part, the requirements of both parts must be met.

Subpart B—Inspections and Tests

Original Certificate of Inspection Requirements

§ 154.40 Purpose.

Sections 154.50 through 154.122 prescribe the original test and inspection requirements for the cargo containment system, process pressure vessels, cargo and process piping, hull heating, and cold spots on liquefied gas vessels for the issuance of an original certificate of inspection for the vessel.

§ 154.50 Integral tanks: Pressure test.

An integral tank must pass in the presence of a marine inspector, a hydrostatic or hydropneumatic test that—

(a) Approximates the design stresses; and

(b) Has a pressure at the top of the tank at least equal to the MARVS.

§ 154.52 Membrane or semi-membrane tanks: Pressure test.

(a) The following pressure test procedures for a membrane or semi-membrane tank must be specially approved by the Commandant (G-MMT):

(1) Hydrostatically, hydropneumatically, or pneumatically testing the tank and any space adjacent to the hull structure that supports the membrane and contains liquid.

(2) Pneumatically testing the hold structure, the pipe tunnel, and any space adjacent to the hull structure that supports the membrane and does not contain liquid.

(b) A membrane or semi-membrane tank must pass, in the presence of a marine inspector, the hydrostatic, hydropneumatic, or pneumatic test specially approved by the Commandant (G-MMT).

§ 154.54 Independent tank type A: Pressure test.

An independent tank type A must pass, in the presence of a marine inspector, one of the following:

(a) A hydrostatic test that—

(1) Approximates the design stresses; and

(2) Has a pressure at the top of the tank at least equal to the MARVS; or

(b) A hydropneumatic test that—

(1) Approximates the service loading of the tank and its supports;

(2) Approximates the design stresses; and

(3) Has a pressure at the top of the tank at least equal to the MARVS.

§ 154.56 Independent tank type B: Pressure test.

Each independent tank type B must pass, in the presence of a marine inspector, a hydrostatic, or a hydropneumatic test that—

(a) Approximates design stresses;

(b) Has a pressure at the top of the tank at least equal to the MARVS;

(c) Has maximum primary membrane stress and maximum bending stress in primary members of less than 90 percent of the yield strength of the fabricated material at the test temperature; and

(d) Has strain gauges or other equipment to monitor the prototype tank during the test if the calculated test stresses exceed 75 percent of the yield strength of the fabricated material.

§ 154.58 Independent tank type C: Pressure test.

(a) An independent tank type C and a process pressure vessel must pass, in the presence of a marine inspector, a hydrostatic test that meets the following requirements:

(1) Section 54.10-10 of this chapter.

(2) The water temperature for the test must be at least 30° C (54° F) warmer than the nil ductility transition temperature of the fabricated material.

(3) The test pressure must be applied for a period of at least—

(i) Two hours; and

(ii) Five minutes for each additional mm of thickness for tank plating greater than 25 mm (1 in.).

(b) If a tank cannot be safely filled with water to meet the requirements under paragraph (a) of this section, the tank must, pass, in the presence of a mine inspector, a hydropneumatic test that is specially approved by the Commandant (G-MMT).

(c) A process pressure vessel must pass, in the presence of a marine inspector, the pneumatic test under § 54.10-15 of this chapter if—

(1) The vessel cannot be safely filled with water to meet the requirements under paragraph (a) of this section; or

(2) The water for the test under paragraph (a) of this section cannot be removed and traces of this water cannot be tolerated during the service of the vessel.

§ 154.60 Cargo tanks: Weld tightness test.

A tank must pass, in the presence of a marine inspector, one of the following weld tightness tests:

(a) Soap bubble test.

(b) Vacuum box test.

(c) A tightness test specially approved by the Commandant (G-MMT).

§ 154.62 Secondary barrier: Weld tightness test.

A secondary barrier for a tank must pass, in the presence of a marine inspector, one of the following tightness tests:

(a) Soap bubble test.

(b) Vacuum box test.

(c) A tightness test specially approved by the Commandant (G-MMT).

§ 154.64 Independent tanks type B: Stress level test.

(a) One independent tank type B and its supports on the first vessel of a class of vessels must have strain gauges to record stress levels during the pressure test after the tank is in the vessel and for the 24 months of service.

(b) The records from the strain gauges required under paragraph (a) of this section must be maintained for the first 24 months that the vessel is in service.

(c) The strain gauge records required under paragraph (b) of this section must be analyzed and specially approved by the Commandant (G-MMT) after the first thirty months that the vessel is in service.

§ 154.66 Cargo and process piping valves: Tightness test.

(a) At least one of each size and type of value in the cargo and process piping systems used at a working temperature lower than −55° C (−67° F) must be tested, including actuation, to at least the minimum design temperature and the maximum design pressure.

(b) A report of the test under paragraph (a) of this section must be specially approved by the Commandant (G-MMT).

§ 154.68 Expansion bellows: Cycles and pressure tests.

(a) The expansion bellows in a cargo system must be approved under § 56.35-15(e) of this chapter or tested as follows:

(1) At least one of each type of expansion bellows in the system must be tested under § 56.35-10 and § 56.35-15 of this chapter;

(2) At least one of each type of element in the expansion bellows, not precompressed, must pass a pressure test of at least five times the design pressure for at least five minutes without bursting.

(3) At least one type of expansion joint with flanges, stays, articulations, and all other accessories, must pass a pressure test under § 56.97-5 of this chapter without permanent deformation at—

(i) Twice the design pressure;

(ii) The extreme displacement conditions recommended by the manufacturer; and

(iii) The minimum design temperature.

(4) If an expansion joint is subject to vessel deformation loads, the expansion joint must pass a cyclic fatigue test—

(i) For at least 2,000,000 cycles at a frequency not higher than five cycles/second;

(ii) By simulating a bellows movement equal to a compensated pipe length; and

(iii) Without internal pressure.

(b) A report of the tests under paragraph (a) of this section must be specially approved by the Commandant (G-MMT).

§ 154.70 Cargo and process piping systems: Hydrostatic test.

The cargo and process piping systems inside and outside a tank must pass, in the presence of a marine inspector—

(a) A hydrostatic test to at least 1.5 times the design pressure after installation on the vessel;

(b) If the systems or part of the systems are manufactured with fittings, a hydrostatic test to at least 1.5 times the design pressure before or after installation on the vessel, except joints welded on board must be tested after installation on the vessel; or

(c) If the water for the test under paragraphs (a) or (b) of this section cannot be removed and traces of the water cannot be tolerated during the service of the vessel, an alternate test that is specially approved by the Commandant (G-MMT).

§ 154.72 Cargo and process piping systems: Leak test.

After installation on the vessel and in the presence of a marine inspector, the cargo and proces piping systems must pass a leak test with air, halides, or another medium at a pressure specially approved by the Commandant (G-MMT).

§ 154.74 Cargo and process piping systems: Functional test.

Before or during the first loading operation and in the presence of a Coast Guard inspector, the cargo and process piping system, including valves, fittings, and associated equipment for loading and discharging cargo or vapor, must be tested to determine if they load and discharge cargo and vapor under operating conditions.

§ 154.76 Integral tank: Production weld test.

An integral tank must pass, in the presence of a marine inspector, the production weld test of a recognized classification society.

§ 154.78 Membrane tank: Production weld test.

A membrane tank must pass, in the presence of a marine inspector, a production weld test that is specially approved by the Commandant (G-MMT).

§ 154.80 Semi-membrane tank; independent tank type A or B: Production weld test.

If a semi-membrane tank or an independent tank type A or B has a service temperature colder than -18° C (0° F), each 50 m (164 ft.) of butt welded joints in the tank must pass, in the presence of a marine inspector, the following production weld tests in the position that the joint is welded:

(a) A bend test under § 57.06-4 of this chapter.

(b) A charpy V-notch test, under § 57.06-5 of this chapter, using 3 specimens with the notch alternately in the center of the weld and the most critical loaction in the heat affected zone.[2]

(c) If a butt welded joint in the tank does not pas the test under paragraph (b) of this section, it must be retested following the procedures under § 54.05-5 (c) of this chapter.

§ 154.82 Independent tank type C and process pressure vessel: Production weld test.

An independent tank type C and process pressure vessel must pass, in the presence of a marine inspector, the production weld tests under Subpart 57.06 of this chapter.

§ 154.84 Secondary barrier: Production weld test.

If a secondary barrier has a service temperature lower than -18° C (0° F) each 50 m (164 ft.) of butt welded joints in the secondary barrier must pass, in the presence of a marine inspector, a production weld test in the position that the joint is welded under—

(a) Section 154.76;

(b) Section 154.78; or

(c) Section 154.80.

§ 154.90 Integral tank: Weld inspection standards.

An integral tank must meet the weld inspection standards of a recognized classification society.

§ 154.92 Membrane tank: Weld inspection standards.

A membrane tank must meet the weld standards specially approved under § 154.425.

§ 154.94 Independent tank type A; semi-membrance tank: Weld inspection standards for shell plating.

(a) For independent tanks type A and semi-membrane tanks with design temperatures of -20° C (-4° F) or colder, each full penetration butt weld of a tank's shell plating must pass a 100 percent radiographic test.

(b) For independent tanks type A and semi-membrane tanks with design temperatures warmer than -20° C (-4° F), each full penetration butt weld intersection of a tank's shell plating must pass a radiographic test and 10 percent of the remaining full penetration butt welds must pass a radiographic test.

§ 154.96 Independent tank type B: Weld inspection standards for shell plating.

For independent tanks type B each full penetration butt weld of a tank's shell plating must pass a—

(a) 100 percent radiographic test; and

(b) 100 percent ultrasonic test under Appendix U of Division 1 of Section VIII, ASME Code, 1974 edition.

§ 154.98 Radiographic inspection standards for welds.

(a) As used in this section:

(1) "t" means the thickness of the thinner portion of the weld.

(2) "Slag inclusion" means a nonmetallic solid material entrapped in weld metal or between weld metal and base metal including oxide and dirt.

(3) "*l*" means the length of the longest imperfection in a group of imperfections.

(b) A full penetration butt weld does not pass the test under § 154.94 or § 154.-96 for the following types of imperfections:

(1) Any crack or zone of incomplete fusion or penetration.

(2) Any elongated slag inclusion that is longer than—

(i) 6.4 mm (¼ in.) for t less than 19.2 mm (¾ in.);

(ii) 8.5 mm (⅓ in.) for t of 19.2 mm (¾ in.) to 57.2 mm (2¼ in.); or

(iii) 19.2 mm (¾ in.) for t more than 57.2 mm (2¼ in.)

(3) Any group of aligned slag inclusions that together are longer than t in a length of 12 t, except when the distance between the successive imperfections exceeds 6*l*.

(4) Any stainless steel wire bristle that is longer than 9.5 mm (⅜ in.) or wider than 1.6 mm (1/16 in.).

(5) Tungsten inclusions in excess of 20 percent of t or 3.2 mm (⅛ in.), whichever is less in any dimension.

(6) Copper inclusions more than 3.2 mm (⅛ in.) in any dimension.

(7) Any dispersed cloud or diffused alloying of metals of higher density than aluminum more than 3.2 mm (⅛ in.) in any dimension.

(8) Metallic and non-metallic inclusions that are closer to each other than four times the length of the longest inclusion.

(9) The cumulative length of metallic inclusions, non-metallic inclusions, or both, that occur within a 3 t or 152.4 mm (6 in.) length of weld, whichever is less, and are greater than 38.1 mm (1½ in.) for nonaligned inclusions and 25.4 mm (1 in.) for aligned inclusions.

(10) The number of metallic inclusions, non-metallic inclusions, or both that occurs within 3 t or 152.4 mm (6 in.) length of weld, whichever is less, is more than seven for nonaligned inclusions and five for aligned inclusions.

(11) Any metallic inclusion lying on or penetrating the surface of the weld or heat affected zone of the weld.

(12) Porosity that exceeds the limits allowed in Appendix IV of Division 1 of Section VIII, of the ASME Code, 1974 edition.

§ 154.100 Semi-membrane tank; independent tank type A or B: Additional weld inspection standards.

The structure of the follcwing tanks, except shell plating, must pass, in the presence of a marine inspector, a magnetic particle or dye penetrant method that is specially approved by the Commandant (G-MMT):

(a) An independent tank type A or a semi-membrane tank designed under § 154.435 as an independent tank type A.

(b) An independent tank type B or a semi-membrane tank designed under § 154.435 as an independent tank type B.

§ 154.102 Independent tank type C: Weld inspection standards.

An independent tank type C must, in the presence of a marine inspector—

[2] The most critical location in the heat affected zone of the weld is based on procedure qualification results except austenitic stainless steel has notches only in the center of the weld.

(a) Meet the requirements under §§ 54.10–1 and 54.10–3 of this chapter;

(b) Pass a 100 percent radiographic test of each full penetration butt weld of the tank's shell plating;

(c) Pass a 10 percent ultrasonic test under Appendix U of Division 1 of Section VIII, ASME Code, 1974 edition, 10 percent magnetic particle, or 10 percent dye penetrant test of all tank welds; and

(d) Pass a 100 percent ultrasonic test under Appendix U of Division 1 of Section VIII, ASME Code, 1974 edition, 100 percent magnetic particle test, or 100 percent dye penetrant test of each weld on reinforcement rings around holes and nozzles.

§ 154.104 Process pressure vessels: Weld inspection standards.

A process pressure vessel must, in the presence of a marine inspector—

(a) Meet the requirements under §§ 54.10–1 and 54.10–3 of this chapter;

(b) Pass a radiographic test of each full penetration butt weld intersection of the tank's shell plating;

(c) Pass a 10 percent radiographic test of each of the remaining full penetration butt welds; and

(d) Pass a 100 percent ultransonic test under Appendix U of Division 1 of Section VIII, ASME Code, 1974 edition, 100 percent magnetic particle test, or 100 percent dye penetrant test of each weld on reinforcement rings around holes and nozzles.

§ 154.106 Cargo and process piping systems inspection standards.

The cargo and process piping systems must meet the inspection requirements under Subpart 56.95 of this chapter.

§ 154.108 Secondary barrier: Inspection standards.

(a) A secondary barrier must pass tests that are specially approved by the Commandant (G–MMT).

(b) If the outer hull of a vessel is part of the secondary barrier, the sheer strake butt welds and the intersections of all but and seam welds in the side of the hull must pass a 100 percent radiographic test.

§ 154.110 First loading and discharging records.

The master shall keep records of the operation of the following during the first loading and discharging of the cargo:

(a) Tanks.
(b) Cargo piping.
(c) Process pressure vessels.
(d) Cargo pumps.
(e) Cargo compressor.
(f) Hull structure heating system.
(g) Pressure and temperature control devices.

§ 154.120 Hull heating systems inspection.

During the first loading and discharge of the cargo, the master shall inspect the hull structure heating system and ensure that it meets the heat output and distribution requirements under §§ 154.174, 154.176, and 154.178.

§ 154.122 Hull cold spot inspection.

(a) A procedure for repairing the cargo containment system to correct hull cold spots must be specially approved by the Commandant (G–MMT).

(b) During the first loading and discharge of the cargo the master shall inspect the hull and ensure that each cold spot is corrected under the procedure required under paragraph (a) of this section.

CERTIFICATION OF INSPECTION RENEWAL REQUIREMENTS

§ 154.130 Purpose.

Sections 154.132 through 154.142 prescribe the requirements for the periodic inspections and tests of the cargo containment system, process pressure vessels cargo and process piping, and hull heating and cold spots for renewal of a liquefied gas vessel's certificate of inspection.

§ 154.132 First 12 month inspection.

During the twelfth month after the month an original certificate of inspection is issued for a liquefied gas vessel under § 31.05–1 of this chapter, the vessel must pass the following inspections in the presence of a marine inspector to retain the original certificate:

(a) An external visual inspection for defects of the following parts of a cargo containment system:

(1) Tank.
(2) Tank support structure, including foundations, chocks, islands, and saddles.
(3) Positioning structure, including keys and keyways.
(4) Equipment hatches.
(5) Personnel access, including hatches.
(6) Penetrations, including piping and electrical cable.
(7) Secondary barrier, except a test under § 154.62 may be substituted if the secondary barrier is inaccessible to the inspector.
(8) Adjacent hull structure.
(9) Insulation, without removing fixed insulation, tank structure, and hull structure.

(b) An internal visual inspection of at least one of each type of tank described in this part, including the cargo equipment and the cargo equipment mountings, for—

(1) Corrosion;
(2) Cracking of base metal;
(3) Weld defects; and
(4) Plating distortion, including buckling.

(c) An inspection of at least one of each type of tank relief valve that includes—

(1) Having defective parts repaired;
(2) The pressure setting test; and
(3) Sealing the pressure setting adjustment.

(d) An inspection for tank tightness by confirming the accuracy of—

(1) The gas detection system;
(2) Temperature measuring devices;
(3) Flow meters; and
(4) Log book entries for tanks.

(e) An external visual inspection of each interbarrier space venting system for—

(1) Corrosion;
(2) Piping distortion;
(3) Leaking piping joints;
(4) Loose piping supports; and
(5) Broken relief valve seals.

(f) An external inspection of each tank venting system for—

(1) Corrosion;
(2) Piping distortion;
(3) Leaking piping joints;
(4) Loose piping supports; and
(5) Broken relief valve seals.

(g) An inspection of the gas leak detection system by—

(1) Confirming the accuracy of the gas leak detection equipment, including indicators and alarms;
(2) A visual inspection of the gas leak detection piping for corrosion and piping distortion; and
(3) Confirming the log book entries for gas detection.

(h) An inspection of the inert gas system by a visual inspection of the—

(1) Inert gas equipment, including generator, storage tanks, indicators, and alarms to determine if they operate; and
(2) Inert gas piping for corrosion and piping distortion.

(i) An external visual inspection of cargo handling piping and machinery, including cargo and process piping, cargo heat exchanges, vaporizers, and compressors, for—

(1) Corrosion;
(2) Piping distortion;
(3) Leaking piping joints; and
(4) Loose piping supports.

(j) An external visual inspection of the hull heating piping coils for—

(1) Corrosion;
(2) Piping distortion;
(3) Leaking piping joints; and
(4) Loose piping supports.

§ 154.134 Each 12 month inspection.

Once during each 12 month period after the inspection under § 154.132 a vessel issued an endorsement under § 154.4 must pass, in the presence of a marine inspector, the inspections under §§ 154.132 (d) through (j) to retain the endorsement.

§ 154.136 Special 48 month and 96 month inspections.

During the 48th month and the 96th month after a vessel is issued an endorsement under § 154.4, the vessel must pass, in the presence of a marine inspector, the inspections under § 154.134 and the following inspections to retain the endorsement:

(a) An internal visual inspection of each tank, except independent tanks type C and process pressure vessels, including inspection of the cargo equipment, and cargo equipment mountings, for—

(1) Corrosion;
(2) Cracking of base metal;
(3) Weld defects; and
(4) Plating distortion, including buckling.

(b) Integral tanks and independent tanks types A and B must pass a hydrostatic or hydropneumatic test at a pressure at the top of the tank that is at least equal to the MARVS.

(c) Membrane and semi-membrane tanks must pass a hydrostatic, hydro-

pneumatic, or pneumatic test specially approved by the Commandant (G-MMT).

(d) An external visual inspection of the tank support structure, including foundations, chocks, islands, and saddles, and the positioning structure, including keys, keyways, sway braces, and antiflotation arrangements, for—

(1) Corrosion;
(2) Distortion;
(3) Cracking of base metal; and
(4) Weld defects.

(e) An external visual inspection of the hull structure that forms a secondary barrier and the contiguous hull structure for—

(1) Corrosion;
(2) Distortion;
(3) Cracking of base metal; and
(4) Weld defects.

(f) An inspection of each relief valve or other relieving device for each interbarrier space that includes—

(1) Having defective parts repaired;
(2) A pressure setting test; and
(3) Sealing the pressure setting adjustment.

(g) An inspection of each tank relief valve that includes—

(1) Having defective parts repaired;
(2) A pressure setting test; and
(3) Sealing the pressure setting adjustment.

(h) A visual inspection of the liquid level indicators for the tanks for—

(1) Corrosion;
(2) Distortion of mechanical parts, and
(3) Loose supports.

(i) An external inspection of each quick closing valve required under §§ 154.530, 154.532, and 154.538 for—

(1) Corrosion;
(2) Distortion;
(3) Leaking piping joints;
(4) Restricted movement of moving parts; and
(5) Failure to close in the time required under § 154.544.

(j) A visual inspection, a pressure vacuum test, or a test specially approved by the Commandant (G-MMT) of the secondary barrier to determine if it meets § 154.460.

§ 154.138 Ninety-six month inspection for independent tank type C and process pressure vessels.

During the 96th month after a vessel is issued an endorsement under § 154.4 each independent tank type C cargo tank and process pressure vessel, including the cargo equipment and the cargo equipment mountings must pass, in the presence of a marine inspector, the following to retain the endorsement:

(a) An internal and external visual inspection for—

(1) Corrosion;
(2) Cracking of base material;
(3) Weld defects; and
(4) Plating distortion, including buckling.

(b) A hydrostatic pressure test to a pressure of at least 1½ times the design vapor pressure, or if the tank cannot be safely filled with water, a test procedure specially approved by the Commandant (G-MMT).

§ 154.140 Special 144 month, 192 month, and 240 month inspections.

In the 144th month, the 192nd month, and the 240th month after a vessel is issued an endorsement under § 154.4, the vessel must pass, in the presence of a marine inspector, inspections under §§ 154.134 and 154.136 (d) through (j) and the following inspections to retain the endorsement:

(a) An internal visual inspection of each tank, except independent tanks type C and process pressure vessels, including inspections of the cargo equipment and the cargo equipment mountings, for—

(1) Corrosion;
(2) Cracking of base metal;
(3) Weld defects; and
(4) Plating distortion, including buckling.

(b) A hydrostatic or hydropneumatic test of each integral tank and independent tank types A and B to a pressure at the top of the tank that is at least equal to the MARVS.

(c) A hydrostatic, hydropneumatic, or pneumatic test specially approved by the Commandant (G-MMT) of each membrane and semi-membrane tank.

(d) A gauging of plating thickness of each tank.

(e) A gauging of plating thickness of each metal secondary barrier that provides structural support for the tank.

§ 154.142 192 month inspection for independent tanks type C and process pressure vessel.

During the 192nd month after a vessel is issued an endorsement under § 154.4, each independent type C cargo tank and process pressure vessel, including the cargo equipment and the cargo equipment mountings, must pass, in the presence of a marine inspector, the following to retain the endorsement:

(a) A visual inspection for—

(1) Corrosion;
(2) Cracking of base metal;
(3) Weld defects; and
(4) Plating distortion, including buckling.

(b) A hydrostatic pressure test to a pressure of at least 1½ times the design vapor pressure, or if the tank cannot be safely filled with water, a test specially approved by the Commandant (G-MMT).

Hull Structure

§ 154.170 Outer hull steel plating.

(a) Except as required in paragraphs (b), (c), and (d) of this section, the outer hull steel plating, including the shell and deck plating must meet the material standards of a recognized classification society.

(b) The deck stringer and sheer strake must be at least Grade E steel or a grade of steel that has equivalent chemical properties, mechanical properties, and heat treatment that is specially approved by the Commandant (G-MMT).

(c) The strake at the turn of the bilge must be Grade D, Grade E, or a grade of steel that has equivalent chemical properties, mechanical properties, and heat treatment that is specially approved by the Commandant (G-MMT).

(d) If the cargo carried causes the outer hull steel temperature to drop below 0° C (32° F), the outer hull steel must—

(1) Be designed for that temperature; and

(2) Meet the standards in § 154.172.

§ 154.172 Contiguous steel hull structure.

(a) Except as allowed in paragraphs (b) and (c) of this section, plates, forgings, forged and rolled fittings, rolled and forged bars and shapes, and castings used in the construction of the contiguous steel hull structure must meet the minimum design temperature, thickness, and steel grade in Table 1:

TABLE 1.—*Minimum design temperature, thickness, and steel grades in contiguous hull structures*

Minimum design temperature	Steel thickness		Steel [1] grade
0°C (32°F)	All		Standards of a recognized classification society.
−10°C (14°F)	12.5 <	t≤12.5 mm (½ in)	B.
		t≤25.5 mm (1 in)	D.
		t>25.5 mm (1 in)	E.
−25°C (−13°F)		t≤12.5 mm (½ in)	D.
		t>12.5 mm (½ in)	E.

[1] Steel grade of a recognized classification society.

(b) For a minimum design temperature below —25° C (—13° F), the contiguous steel hull structure must meet § 154.610, except the steel thickness limitation.

(c) If a steel grade that is not listed in Table 1 has the equivalent chemical properties, mechanical properties, and heat treatment of a steel grade that is listed, the steel grade not listed may be used if specially approved by the Commandant (G-MMT) for use in the contiguous hull structure.

§ 154.174 Transverse contiguous hull structure.

(a) The transverse contiguous hull structure of a vessel having tanks without secondary barriers must meet the standards of a recognized classification society.

(b) The transverse contiguous hull structure of a vessel having tanks with secondary barriers must have a minimum design temperature that is—

(1) Colder than the calculated temperature of this hull structure assuming the—

(i) Temperature of the secondary barrier to be the temperature of the cargo carried; and

(ii) Ambient cold condition required under § 154.176(b)(1) (ii) and (iii); or

(2) Temperature maintained by the heating system under § 154.178.

(c) A heat load calculation must show that the heating system meets paragraph (b)(2) of this section.

§ 154.176 Longitudinal contiguous hull structure.

(a) The longitudinal contiguous hull structure of a vessel having tanks without secondary barriers must meet the standards of a recognized classification society.

(b) The longitudinal contiguous hull structure of a vessel having tanks with secondary barriers must have a minimum design temperature that is—

(1) Colder than the calculated temperature of this hull structure assuming the—

(i) Temperature of the secondary barrier is the temperature of the cargo carried; and

(ii) For any waters in the world except Alaskan waters, ambient cold condition of—

(A) Five knots air at −18° C (0° F); and

(B) Still sea water at 0° C (32° F); or

(iii) For Alaskan waters the ambient cold condition of—

(A) Five knots air at 29° C (−20° F); and

(B) Still sea water at 2° C (28° F); or

(2) Maintained by the heating system under § 154.178, if, without heat, the contiguous hull structure has at least a minimum design temperature that is colder than the calculated temperature of the hull structure assuming the—

(i) Temperature of the secondary barrier is the temperature of the cargo carried; and

(ii) Ambient cold conditions of still air at 5° C (41° F) and still sea water at 0° C (32° F).

(c) A heat load calculation must show that the heating system meets pargraph (b)(2) of this section.

§ 154.178 Contiguous hull structure: Heating system.

The heating system for transverse and longitudinal contiguous hull structure is an essential auxiliary and must—

(a) Have the heating capacity to meet § 154.174 of § 154.176;

(b) Have stand-by heating to provide 100 percent of the required heat load and distribution determined under § 154.174 (c) and § 154.176(c); and

(c) Meet Parts 52, 53, and 54 of this chapter.

§ 154.180 Contiguous hull structure: Welding procedure.

Welding procedure tests for contiguous hull structure with a design temperature colder than −18° C (0° F) must meet § 54.05–15 and Part 57.03 of this chapter.

§ 154.182 Contiguous hull structure: Production weld test.

If the contiguous hull structure has a design temperature colder than −34° C (−30° F), each 50 m (164 ft.) of full penetration butt welded joints in the contiguous hull structure must pass, in the presence of a Coast Guard inspector, the following production weld tests in the position that the joint is welded:

(a) A bend test under § 57.06–4 of this chapter.

(b) A charpy V-notch test under § 57.06–5 of this chapter from 3 specimens with the notch alternately located in the center of the weld and the most critical location in the heat affected zone.[2]

(c) If the contiguous hull structure does not pass the test under paragraph (b) of this section, the retest procedures under § 54.05–5(c) must be used.

§ 154.188 Membrane tank: Inner hull steel.

For a vessel with membrane tanks, the inner hull plating thickness must meet the deep tank requirements of a recognized classification society.

§ 154.195 Aluminum tank: Steel enclosure.

(a) An aluminum tank and its dome must be enclosed by the vessel's hull structure or a separate steel cover.

(b) The steel cover for the aluminum tank must meet the steel structural standards of a recognized classification society.

(c) The steel cover for the aluminum tank dome must be—

(1) At least 3 mm (⅛ in.) thick;

(2) Separated from the tank dome, except at the support points; and

(3) Thermally isolated from the dome.

SHIP SURVIVAL CAPABILITY AND CARGO TANK LOCATION

§ 154.200 Stability requirements: General.

Each vessel must be stable for the full range of drafts taking into account any empty or partially filled tanks and the weight and volume of the cargoes carried.

§ 154.205 Intact stability requirements.

(a) Each vessel must meet Part 93 of this chapter.

(b) During loading and unloading the vessel must have at least 50 mm (2 in.) of positive metacentric height.

§ 154.210 Damage stability requirement.

Each vessel must be shown by design calculations to meet the survival presumptions in § 154.230 assuming the damage for the cargo it carries in the hull type specified in § 154.215.

154.215 Hull type calculation.

(a) Where Table 4 requires a type I G hull, design calculations must show that the vessel can survive damage at any location.

(b) Where Table 4 requires a type II G hull, design calculations must show that a vessel—

(1) Longer than 150 m (492.15 ft.) in length can survive damage at any location; and

(2) 150 m (492.15 ft.) long or shorter can survive damage at any location except the transverse bulkheads bounding an aft machinery space.

(c) If a vessel has independent tanks Type C with a MARVS of 7 kp/cm² (100 psig) and Table 4 allows a type II PG hull the design calculations must show that a 150 m (492.15 ft.) long or shorter vessel can survive damage at any location, except on transverse bulkheads spaced farther apart than the longitudinal extent of damage specified in § 154.220(a)(1).

(d) Where Table 4 requires a type III G hull, design calculations must show that a vessel—

(1) 125 m (410.13 ft.) or longer can survive damage at any location except on transverse bulkheads spaced farther apart than the longitudinal extent of damage specified in § 154.230(a)(1); and

(2) Shorter than 125 m (410.13 ft.) can survive damage at any location, except on transverse bulkheads spaced farther apart than the longitudinal extent of damage specified in § 154.220(a)(1) and except in the main machinery space.

(e) For the purposes of paragraphs (c) and (d) of this section, damage must be assumed to transverse bulkheads spaced closer than the longitudinal extent of damage specified in § 154.220(a)(1), and a main transverse bulkhead or a transverse bulkhead bounding side tanks or double bottom tanks must be assumed damaged if there is a step or a recess in a transverse bulkhead that is longer than 3 m (10 ft.) located within the extent of penetration of assumed damage. The step formed by the after peak bulkhead and after peak tank top is not a step for the purpose of this regulation.

§ 154.220 Damage calculations.

(a) For the purpose of § 154.210, design calculations must assume both side and bottom damage, applied separately.

(b) Damage must consist of the most disabling penetration up to and including penetrations having the following dimensions:

(1) *Side penetration.*

(i) Longitudinal extent: 1/3 $L^{2/3}$ or 14.5 m (0.495 $L^{2/3}$ or 47.6 ft.), whichever is shorter.

(ii) Transverse extent (inboard from the ship's side at right angles to the centerline at the level of the summer load line assigned under subchap. E): B/5 or 11.5 m (37.7 ft.), whichever is shorter.

(iii) Vertical extent: from the base line upward without limits:

(2) *Bottom penetration.*

At the forward end but excluding any damage aft of a point 0.3 L aft of forward perpendicular:

(i) Longitudinal: ⅓ $L^{2/3}$ or 14.5 m (.495 $L^{2/3}$ or 47.6 ft.), whichever is shorter.

(ii) Transverse: B/6 or 10 m (32.8 ft.), whichever is shorter.

(iii) Vertical extent from the molded line of the shell at the centerline: B/15 or 2 m (6.6 ft.), whichever is shorter.

[2] The most critical location in the heat affected zone of the weld is based on procedure qualification results, except austenitic stainless steel has notches only in the center of the weld.

At any longitudinal position aft of a point 0.3 L aft of the forward perpendicular:
(i) L/10 or 5 m (16.4 ft.), whichever is shorter.
(ii) B/6 or 5 m (16.4 ft.), whichever is shorter.
(iii) B/15 or 2 m (6.6 ft.), whichever is shorter.

(c) When the damage assumption excludes a transverse bulkhead bounding a machinery space, the machinery space must be assumed to be damaged as a case separate from the side and bottom peneration.

§ 154.225 Permeability of spaces and free surface effect.

(a) The free surface effect must be calculated at an angle of heel of 5° for each individual space or the effect of free liquid in a tank must be calculated by assessing the shift of liquids by moment of transference calculations.

(b) In calculating the effect of free surfaces of consumable liquids, it must be assumed that, for each type of liquid, at least one transverse pair of wing tanks or a single center line tank has a free surface, and the tank or combination of tanks must be selected where the effect of free surfaces is the greatest.

(c) Calculations in which a machinery space is treated as a floodable space must be based on an assumed machinery space permeability of 0.85, unless the use of an asumed permeability of less than 0.85 is justified in detail.

(d) The assumed permeability of a floodable space other than a machinery space must be as follows:

(1) Storerooms, 0.60; (2) Accommodation spaces, 0.95; (3) void, 0.95; (4) consumable liquid tanks, 0.95 or 0, whichever results in the more disabling; (5) other liquid tanks, 0.95 or 0.[4]

Wherever damage penetrates a cargo tank it must be assumed that the cargo is completely lost from the compartment and replaced by salt water up to the level of the final plane of equilibrium.

§ 154.230 Damage survival.

A vessel is presumed to survive assumed damage if it meets the following conditions in the final stage of flooding:

(a) *Heel angle.* The maximum angle of heel must not exceed 30°.

(b) *Final waterline.* The waterline, taking into account sinkage, heel and trim, must be below the lower edge of openings such as air pipes and openings closed by weathertight doors or hatch covers, except openings closed by means of watertight manhole covers and watertight flush scuttles, small watertight cargo tank hatch covers that maintain the high integrity of the deck, remotely operated watertight sliding doors, and side scuttles of the non-opening type.

(c) *Range of stability.* (1) The righting lever curve must be positive and have a minimum range of 20° beyond the angle of equilibrium.

(2) The maximum righting lever within the range specified in paragraph (c)(1) of this section must be at least 100 mm (3.9 in.).

(3) Each opening within the 20° range beyond the angle of equilibrium must be at least weathertight.

(d) *Local damage.* The maximum angle of heel must not exceed the greater of 30° or the angle at which restoration of propulsion, steering engine power and use of the ballast system is precluded for local damage, extending 760 mm (29.9 in.) normal to the hull shell, that affects a—

(1) Longitudinal bulkhead; and

(2) Transverse bulkhead on type IG and IIG vessels.

(e) *Equalization arrangements.* Equalization arrangements requiring mechanical aids such as valves or cross-flooding lines may not be considered for reducing the angle of heel. Spaces joined by ducts of large cross sectional area are treated as common spaces.

(f) *Progressive flooding.* If pipes, ducts, or tunnels are within the assumed extent of damage, arrangements must be made to prevent progressive flooding in a space that is not assumed to be flooded in the damaged stability calculations. If an intermediate stage of flooding is more critical than the final stage, calculations for the intermediate stage must be submitted for special approval by Commandant (G-MMT).

§ 154.235 Tank location.

(a) For type IG hulls, cargo tanks must be located inboard of—

(1) The transverse damage specified in § 154.220(b)(1)(ii);

(2) The verticle damage specified in § 154.220(b)(2)(iii); and

(3) 760 mm (30 inches) from the shell planting.

(b) For type IIG, IIPG, and IIIG hulls cargo tanks must be located inboard of—

(1) The vertical extent of damage specified in § 154.220(b)(2)(iii); and

(2) 760 mm (30 inches) from the shell plating.

(c) In vessels having membrane and semi-membrane tanks, the vertical and transverse extents of damage must be measured to the inner hull.

(d) For type IIG, IIPG, and IIIG hulls, tank suction wells may penetrate into the area of bottom damage specified in § 154.220(b)(2)(iii) if the penetration is the lesser of 25 percent of the double bottom height or 350 mm (13.8 in.).

SHIP ARRANGEMENTS

§ 154.300 Segregation of hold spaces from other spaces.

Hold spaces must be segregated from machinery and boiler spaces, accommodation, service and control spaces, chain lockers, potable, domestic and feed water tanks, store rooms and spaces immediately below or outboard of hold spaces by a—

(a) Cofferdam, fuel oil tank, or single gastight A-60 Class Division of all welded construction in a cargo containment system not requiring a secondary barrier;

(b) Cofferdam or fuel oil tank in a cargo containment system requiring a secondary barrier; or

(c) If there are no sources of ignition or fire hazards in the adjoining space, single gastight A-O Class Division of all welded construction.

§ 154.305 Segregation of hold spaces from the sea.

In vessels having cargo containment systems requiring a secondary barrier, hold spaces must be segregated from the sea by—

(a) A double bottom if the cargo tanks are approved for temperatures colder than −10° C (14° F); and

(b) Wing tanks if the cargo tanks are approved for temperatures colder than −55° C (−67° F).

§ 154.310 Cargo piping systems.

Cargo liquid or vapor piping must—

(a) Be separated from other piping systems, except where an interconnection to inert gas or purge piping is required by § 154.901(a);

(b) Not enter or pass through any accommodation, service, or control space;

(c) Except as allowed under § 154.703, not enter or pass through a machinery space other than a cargo pump or compressor room;

(d) Be in the cargo area above the open deck, except for bow and stern loading and emergency dumping;

(e) Connect into the cargo containment system above the open deck except—

(1) Pipes in a trunk traversing void spaces above a cargo containment system; and

(2) Pipes in cofferdams for draining, venting, or purging interbarrier and hold spaces; and

(f) Be inboard of the transverse tank location required by § 154.206, except for thwartship shore connection manifolds not subject to internal pressure at sea.

§ 154.315 Cargo pump and compressor rooms.

(a) Cargo pump rooms and cargo compressor rooms must be above the open deck and within the cargo area.

(b) Where pumps and compressors are driven by a prime mover in an adjacent gas safe space—

(1) The bulkhead or deck must be gastight; and

(2) The shafting passing through the bulkhead or deck must be sealed by a fixed oil reservoir gland seal or other positive pressure seal specially approved by the Commandant (G-MMT).

§ 154.320 Cargo control stations.

(a) Cargo control stations must be above the open deck.

(b) If a cargo control station is in accommodation, service, or control space or has access to such a space, the station must—

(1) Be a gas safe space;

(2) Have an access to the space that meets § 154.30; and

(3) Have indirect reading instrumentation, except for gas detectors.

(c) Cargo control stations, including a room or area, must contain all alarms, indicators, and remote controls associated with each tank that the station controls.

[4] The permeability of partially filled tanks must be consistent with actual density and amount of liquid carried.

§ 154.325 Accommodation, service, and control spaces.

(a) Accommodation, service, and control spaces must be outside the cargo area.

(b) If a hold space having a cargo containment system that requires a secondary barrier is separated from any accommodation, service, or control space by a cruciform joint, there must be a cofferdam on one side of the cruciform joint.

§ 154.330 Openings to accommodation, service, or control spaces.

(a) Entrances, forced or natural ventilation intakes and exhausts, and other openings, except as allowed in paragraph (c) of this section, must be—

(1) At least L/25 or 3 m (10 ft) from the athwartship bulkhead facing the cargo area, whichever is farther, except that the distance need not exceed 5 m (16.4 ft); and

(2) On a house athwartship bulkhead not facing the cargo area or on the outboard side of the house.

(b) Port lights located on the athwartship bulkhead of a house facing the cargo area, or the house sides within L/25 or 5 m (16.4 ft), whichever is less, must not open.

(c) Wheelhouse doors and windows that open may be within L/25 or 5 m (16.4 ft), whichever is less, of the athwartship bulkhead of a house facing the cargo area, if they have gaskets and dogs to make them watertight when tested with a fire hose at not less than 2.11 kp/cm² (30 psig).

(d) Port lights in the hull plating below the uppermost continuous deck and in the first tier of the superstructure must not open.

(e) Air intakes and openings into accommodation, service and control spaces must have—

(1) Gasketed metal covers; and

(2) On toxic cargo vessels, covers that can be closed from inside the space.

§ 154.340 Access to tanks and spaces in the cargo area.

In the cargo area—

(a) Each cargo tank must have a manhole from the open deck, the clear opening of which is at least 600 mm by 600 mm (23.6 in. by 23.6 in.);

(b) Each access to a hold space, void space, or other gas dangerous space must have a clear opening of at least 600 mm by 600 mm (23.6 in. by 23.6 in.);

(c) Each manhole through bulkheads, frames, or other vertical structural member must have a clear opening of at least 600 mm (23.6 in.) by 800 mm (31.5 in.) and be at most 600 mm (23.6 in.) from the deck or bottom plating unless there is a fixed ladder;

(d) Each access trunk must be at least 760 mm (30 in.) in diameter.

(e) The lower edge of each access from the open deck to gas safe spaces in the cargo area must be at least 2.4 mm (7.87 ft.) above the open deck or through an air lock that meets § 154.345;

(f) The inner hull must be accessible for inspection from at least one side without the removal of any fixed structure or fitting; and

(g) The hold space insulation must be accessible for inspection from at least one side from within the hold space while the tank is at the cargo temperature unless an inspection method from outside of the hold space is specially approved by the Commandant (G-MMT).

§ 154.345 Air locks.

(a) An air lock may be used for access from a gas dangerous zone on the open deck to a gas safe space in the cargo area.

(b) Each air lock must—

(1) Consist of two steel doors, at least 1.5 m (4.92 ft.) but not more than 2.5 m (8.20 ft.) apart each gasketed and dogged and watertight when tested with a fire hose at not less than 2.11 kp/cm² (30 psig);

(2) Have self-closing doors with no latches or other devices for holding them open;

(3) Have an audible and visual alarm on both sides actuated when the securing devices on both doors move from the fully closed position at any one time;

(4) Have mechanical ventilation in the space between the doors from a gas safe area;

(5) Have a pressure greater than that of the gas dangerous area on the open deck;

(6) Have the rate of air change in the space between the doors of at least 12 changes per hour;

(7) Have the space between the doors monitored for cargo vapor leaks under § 154.1350; and

(c) In addition to the requirements of paragraphs (a) and (b) of this section, no gas safe space on a liquefied flammable gas carrier may have an air lock unless the space—

(1) Is mechanically ventilated to make the pressure in the space greater than that in the air lock; and

(2) Has a means of automatically deenergizing all electrical equipment that is not explosion-proof in the space when the pressure in the space falls to or below the pressure in the air lock.

§ 154.350 Bilge and ballast systems in the cargo area.

(a) Hold, interbarrier, and insulation spaces must have a means of sounding the space or other means of detecting liquid leakage acceptable to the Commandant (G-MMT).

(b) Each hold and insulation space must have a bilge drainage system.

(c) Interbarrier spaces must have an educator or pump for removing liquid cargo and returning it to the cargo tanks or to an emergency dump.

(d) Spaces in the cargo containment portion of the vessel, except ballast spaces and gas safe spaces, must not connect to pumps in the main machinery space.

§ 154.355 Bow and stern loading piping.

(a) Bow and stern loading piping must—

(1) Meet § 154.310;

(2) Be installed in an area away from the accommodation, service, or control space on type I G hulls;

(3) Be clearly marked;

(4) Be segregated from the cargo piping by at least two shut off valves in the cargo area that has a means of locking to meet § 154.1870(a);

(5) Have a means for checking cargo vapor between the two valves required in paragraph (a)(3) of this section;

(6) Have fixed inert gas purging lines; and

(7) Have fixed vent lines for purging with inert gas to meet § 154.1870(b).

(b) Entrances, forced or natural ventilation intakes, exhaust, and other openings to accommodation, service, or control spaces that face the bow or stern loading area must meet §§ 154.330.

CARGO CONTAINMENT SYSTEMS

§ 154.401 Definitions.

As used §§ 154.440 and 154.447:

"σ_T" means the minimum yield stress of the tank material, including weld metal, at room temperature.

"σB" means minimum tensile strength of the tank material, including weld metals at room temperature.

§ 154.405 P_o of a tank.

(a) The P_o of a tank must be equal to or greater than the MARVS.

(b) The P_o of a tank must be equal to or greater than the vapor pressure of the cargo at 45° C (113° F) if—

(1) The tank has no temperature control for the cargo; and

(2) The pressure of the cargo results from ambient temperature.

(c) The P_o of a tank may be less than the vapor pressure for harbor conditions if specially approved by the Commandant (G-MMT).

§ 154.406 Design loads for tanks and fixtures: General.

(a) It must be shown that a tank and its fixtures are designed for the following loads:

(1) Internal pressure head.

(2) External pressure load.

(3) Dynamic loads resulting from the motion of the vessel.

(4) Transient or stationary thermal loads if the cargo temperature is colder than −55° C (−67° F) or causes thermal stresses in tank support.

(5) Sloshing loads, if the tank is designed for partial loads.

(6) Loads resulting from vessel's deflection.

(7) Tank weight, cargo weight, and corresponding support reaction.

(8) Insulation weight.

(9) Loads of a tower and any other attachments to the tank.

(10) Vapor pressure loads in harbor conditions allowed under § 154.405.

(11) Gas pressurization for cargo transfer load.

(b) A tank must be designed for the most unfavorable static heel angle within a 0° to 30° range without exceeding the allowable stress of the material.

(c) A hydrostatic or hydropneumatic test design load must be specially approved by the Commandant (G-MMT).

§ 154.407 Tank internal pressure head.

(a) For the calculation required under § 154.406(a), the internal pressure head (h_{eq}), must be determined from the following formula:

$$h_{eq}=10\,P_o+(h_{\beta d})\ \max$$

$h_{\beta d}$ (the value of internal pressure, in meters of fresh water, resulting from the combined effects of gravity and dynamical accelerations of a full tank) $=a_{\beta\beta}z$;
where

a_β = Dimensionless acceleration relative to the acceleration of gravity, resulting from gravitational and dynamical loads in the β direction (see figure 1);

Z_β = Largest liquid height (m) above the point where the pressure is to be determined in the β direction (see figure 2);

λ = Maximum specific weight of the cargo (t/m^3) at the design temperature.

(b) The $h_{\beta d}$ max must be determined from the β max direction on the ellipse in Figure 1 which gives the maximum value.

(c) When the longitudinal acceleration is considered in addition to the vertical and tranverse acceleration, an ellipsoid must be used in the calculations instead of the ellipse contained in Figure 1.

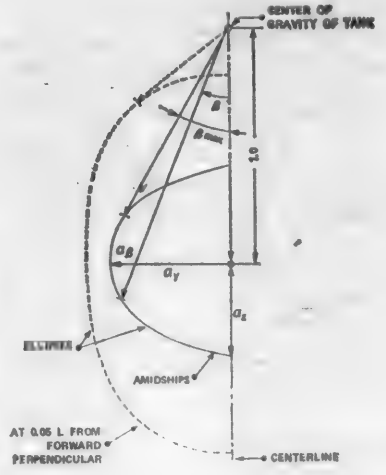
§ 154.408 Tank external pressure load.

For the calculation required under § 154.406(b), the external pressure load must be the difference between the minimum internal pressure (maximum vacuum), and the maximum external pressure to which any portion of the tank may be simultaneously subjected.

§ 154.409 Dynamic loads from vessel motion.

(a) For the calculation required under § 154.406(c), the dynamic loads must be determined from the long term distribution of vessel motions, including the effects of surge, sway, heave, roll, pitch, and yaw on irregular seas that the vessel may experience during 10^8 wave encounters. The speed used for this calculation may be reduced from the ship service speed if specially approved by the Commandant (G–MMT) and if that reduced speed is used in the hull strength calculation under § 31.10–5(c) of this chapter.

(b) If the loads determined under paragraph (c), (d), or (e) of this section results in a design stress that is lower than the allowable stress of the material under §§ 154.610, 154.615, or 154.620, reduce the allowable stress to that stress determined in paragraph (c), (d), or (e) of this section.

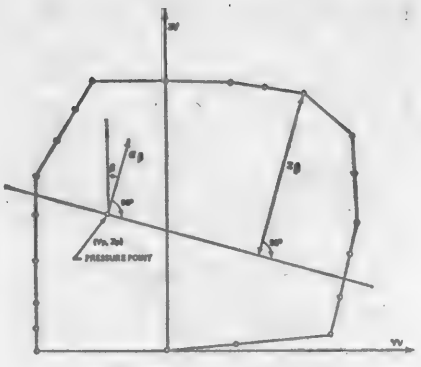


NOTE: RESULTING ACCELERATION (STATIC + DYNAMIC) = a_β IN ARBITRARY DIRECTION β.

a_y = TRANSVERSE COMPONENT OF ACCELERATION.

a_z = VERTICAL COMPONENT OF ACCELERATION.

Figure 1



NOTE: LARGEST LIQUID HEIGHT ABOVE THE POINT WHERE THE PRESSURE IS DETERMINED = Z_β

Figure 2

(c) If a tank is designed to avoid plastic deformation and buckling, then acceleration components of the dynamic loads are determined from one of the following methods:

(1) Method 1 is a detailed analysis of the vessels acceleration components.

2. Method 2 is an analysis by the following formulae:

(i) Vertical acceleration under § 154.409(f)(1):

$$a_z=\pm a_o\sqrt{1+\left(5.3-\frac{45}{L_o}\right)^2\left(\frac{x}{L_o}+0.05\right)^2\left(\frac{0.6}{C_B}\right)^{3/2}}$$

(ii) Transverse acceleration under § 154.409(f)(2):

$$a_y=\pm a_o\sqrt{0.6+2.5\left(\frac{x}{L_o}+0.05\right)^2+K\left(1+0.6K\,\frac{z}{B}\right)^2}$$

(iii) Longitudinal acceleration under § 154.409(f)(3):

$$a_x=\pm a_o\sqrt{0.06+A^2-0.25A}$$

where:

$$A=\left(0.7-\frac{L_o}{1200}+5\,\frac{z}{L_o}\right)\left(\frac{0.6}{C_B}\right)$$

L = Length of the vessel between perpendiculars, in meters.

C_B = Block coefficient.

B = Greatest moulded breadth, in meters.

x = Longitudinal distance, in meters, from amidships to the center of gravity of the tank with contents (positive forward of amidships, negative aft of amidships).

z = Vertical distance in meters, from the vessel's waterline, to center of gravity of tank with contents (positive above and negative below the waterline).

$$a_o=0.2\,\frac{V}{\sqrt{L_o}}+\frac{34-\frac{600}{L_o}}{L_o}$$

V = Service speed in knots.

$K=1.0$, or $\frac{13\,GM}{B}$, whichever is greater.

GM = Metacentric height in meters.

a_x = The maximum dimensionless acceleration in the x direction, acting separately for calculation purposes, and includes the component of the static weight in the longitudinal direction due to pitching.

a_y = Maximum dimensionless acceleration in the y direction, acting separately for calculation purposes, and includes the component of static weight in the transverse direction due to rolling.

a_z = Maximum dimensionless acceleration in the z direction, acting separately for calculation purposes, not including the static weight.

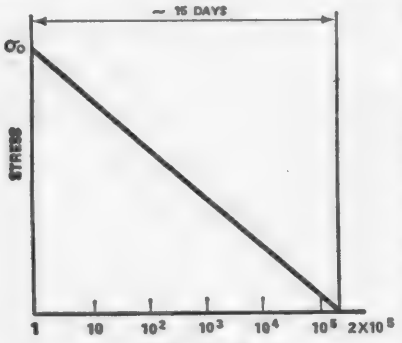
For Methods 1 and 2, acceleration components must be determined for the largest loads the vessel may experience during an operating life correspond to the probability level of 10^{-8}.

(d) If a tank is designed to avoid fatigue, the dynamic loads determined under paragraph (a) of this section must be used to develop the dynamic spectrum.

(e) If a tank is designed to avoid uncontrolled crack propogation, the dynamic loads are—

(1) determined under paragraph (a) of this section; and

(2) for a load distribution for a period of 15 days by the method in Figure 3.



NOTE: σ_o = MOST PROBABLE MAXIMUM STRESS DURING THE LIFE OF THE VESSEL.

RESPONSE CYCLE SCALE IS LOGARITHMIC.

THE VALUE OF $2X10^5$ IS GIVEN AS AN EXAMPLE OF ESTIMATE.

Figure 3

(f) When determining the accelerations for dynamic loads under paragraph (a) of this section, the accelerations acting in a tank must be estimated for the tank's center of gravity and include the following component accelerations:

(1) Vertical accelerations, meaning the motion acceleration of heave and pitch, and of any roll normal to the vessel base that has an effect on the component acceleration.

(2) Transverse acceleration, meaning the motion acceleration of sway, yaw and roll, and gravity component of roll.

(3) Longitudinal acceleration, meaning the motion acceleration of surge and pitch and gravity component of pitch.

§ 154.410 Tank sloshing loads.

(a) For the calculation required under § 154.406(a)(5), the determined sloshing loads resulting from the accelerations under § 154.409(f) must be specially approved by the Commandant (G-MMT).

(b) If the sloshing loads affect the tank scantlings, an analysis of the effects of the sloshing loads in addition to the calculation under paragraph (a) of this section must be specially approved by the Commandant (G-MMT).

§ 154.411 Tank thermal loads.

For the calculations required under § 154.406(d), the following determined loads must be specially approved by the Commandant (G-MMT):

(a) Transient thermal loads for the cooling down periods of tanks carrying cargoes lower than −55° C (−67° F).

(b) Stationary thermal loads for tanks carrying cargoes lower than −55° C (−67° F) that cause high thermal stress.

§ 154.412 Tank corrosion allowance.

A tank must be designed with a corrosion allowance if the tank—

(a) Is located in a space that does not have inert gas or dry air; or

(b) Carries a cargo that corrodes the tank material.

NOTE.—Corrosion allowance for independent tank type C is contained in § 54.01-35 of this chapter.

INTEGRAL TANKS

§ 154.418 General.

Integral tanks must not carry cargo that is colder than −10°C (14°F), unless the tank is specially approved by the Commandant (G-MMT).

§ 154.419 Design vapor pressure.

The P_o of an integral tank must not exceed 0.25 kp/cm² (4 psig) except it may be as high as 0.7 kp/cm² (10 psig) if specially approved by the Commandant (G-MMT).

§ 154.420 Tank scantlings.

(a) The scantlings of an integral tank must meet the deep tank scantling standard of a recognized classification society.

(b) The scantlings of an integral tank must be designed and shown by calculation to withstand the internal pressure determined under § 154.407.

§ 154.421 Allowable stress.

The allowable stress for integral tank scantlings must meet a recognized classification society's allowable stress for the vessel's hull.

MEMBRANE TANKS

§ 154.425 General.

The design of the hull scantlings, the membrane tank and secondary barrier, including welds, and the supporting insulation must be specially approved by the Commandant (G-MMT).

§ 154.426 Design vapor pressure.

The P_o of a membrane tank must not exceed 0.25 kp/cm² (4 psig), except it may be as high as 0.7 kp/cm² (10 psig), if specially approved by the Commandant (G-MMT).

§ 154.427 Tank scantlings.

The scantlings of a membrane tank must have a membrane and supporting insulation that is designed for—

(a) Any static and dynamic loads with respect to plastic deformation and fatigue;

(b) Combined strains from static, dynamic, and thermal loads;

(c) Preventing collapse of the membrane from—

(1) Over-pressure in the interbarrier space;

(2) Vacuum in the cargo tank;

(3) Sloshing in a partially filled tank; and

(4) Hull vibrations; and

(d) The deflections of the vessel's hull.

§ 154.428 Allowable stress.

The membrane tank scantlings and the supporting insulation must have allowable stresses that are specially approved by the Commandant (G-MMT).

§ 154.429 Calculations.

For a membrane tank, the tank design load calculations must include the following:

(a) Plastic deformation and fatigue life resulting from static and dynamic loads in the membrane and the supporting insulation.

(b) The response of the membrane and its supporting insulation to vessel motion and acceleration under the worse weather conditions. Calculations from a similar vessel may be submitted.

(c) The combined strains from static, dynamic, and thermal loads.

§ 154.430 Material test.

The analyzed data of a material test must show that the membrane and the membrane supporting insulation are made of materials that withstand the combined strains calculated under § 154.429(c).

§ 154.431 Model test.

The analyzed data of a model test must show that the primary and secondary barrier of a membrane tank, including the corners and joints, withstand the combined strains from static, dynamic, and thermal loads calculated under § 154.429(c).

§ 154.432 Expansion and contraction.

The support system of a membrane tank must allow for thermal and physical expansion and contraction of the tank.

SEMI-MEMBRANE TANKS

§ 154.435 General.

(a) The design of the semi-membrane tank, the supporting insulation for the tank, and the supporting hull structure for the tank must be specially approved by the Commandant (G-MMT).

(b) A semi-membrane tank must be designed to meet the requirements under—

(1) Section 154.425 through § 154.432;

(2) Section 154.437 through § 154.441; or

(3) Section 154.444 through § 154.449.

§ 154.436 Design vapor pressure.

The P_o of a semi-membrane tank must not exceed 0.25 kp/cm² (4 psig), except it may be as high as 0.7 kp/cm² (10 psig), if specially approved by the Commandant (G-MMT).

INDEPENDENT TANK TYPE A

§ 154.437 General.

The tank scantlings of an independent tank type A must meet the standard of a recognized classification society.

§ 154.438 Design vapor pressure.

(a) If the surfaces of an independent tank type A are mostly flat surfaces, the P_o must not exceed 0.7 kp/cm² (10 psig).

(b) If the surfaces of an independent type A are formed by bodies of revolution, the design calculation of the P_o must be specially approved by the Commandant (G–MMT).

§ 154.439 Tank scantlings.

(a) The scantlings of an independent tank type A must meet the deep tank standard of a recognized classification society.

(b) The scantlings of an independent tank type A must—

(1) Withstand the internal pressure determined under § 154.407;

(2) Withstand loads from tank supports calculated under §§ 154.470 and 154.471; and

(3) Have a corrosion allowance that meets § 154.412.

§ 154.440 Allowable stress.

(a) The allowable stresses for an independent tank type A are—

(1) For tank web frames, stringers, or girders of carbon maganese steel or aluminum alloys must meet σ or, σ, $\frac{B}{2.66}$ $\frac{Y}{1.33}$ whichever is smaller; and

(2) For other materials, specially approved by the Commandant (G–MMT).

(b) A larger allowable stress than required in paragraph (a)(1) of this section may be specially approved by the Commandant (G–MMT) if the aquivalent stress (σ_e) is calculated from the formula in Appendix A to this part.

(c) Tank plating must meet the requirements of a recognized classification society for deep tanks having an internal pressure head that meets § 154.439 (b)(1).

INDEPENDENT TANK TYPE B

§ 154.444 General.

An independent tank type B must be designed—

(a) For the effect of static and dynamic loads on—

(1) Plastic deformation; (2) Fatigue life; (3) Buckling; and (4) Crack propagation; and

(b) From the results of the calculations under § 154.448.

§ 154.445 Design vapor pressure.

If the surfaces of an independent tank type B are mostly flat surfaces, the P_o must not exceed 0.7 kp/cm² (10 psig).

§ 154.446 Tank scantlings.

The tank scantlings of an independent tank type B must meet the calculations under § 154.448.

§ 154.447 Allowable stress.

(a) An independent tank type B designed from bodies of revolution must have allowable stresses [5] determined by the following formulae:

$$\sigma_m \leq f$$
$$\sigma_L \leq 1.5f$$
$$\sigma_b \leq 1.5F$$
$$\sigma_L + \sigma_b \leq 1.5F$$
$$\sigma_m + \sigma_b \leq 1.5F$$

where:

σ_m = Equivalent primary general membrane stress [6]
σ_L = Equivalent primary local membrane stress [6]
σ_b = Equivalent primary bending stress [6]

f = The lesser of $\frac{\sigma_B}{A}$ or $\frac{\sigma_Y}{B}$

F = The lesser of $\frac{\sigma_B}{C}$ or $\frac{\sigma_Y}{D}$

A, B, C, and D = Stress factors in table 2.

[5] See app. B for stress analyses definition.
[6] See app. A for equivalent stress.

TABLE 2.—*Values for stress factors*

Stress factors	Nickel steel and carbon manganese steel values	Austenitic steel values	Aluminum alloy values
A	0.4	0.4	0.4
B	.2	1.6	1.5
C	.3	.3	.3
D	1.5	1.5	1.5

(b) An independent tank type B designed from plane surfaces must have allowable stresses specially approved by the Commandant (G–MMT).

§ 154.448 Calculations.

The following calculations for an independent tank type B must be specially approved by the Commandant (G–MMT):

(a) Plastic deformation, fatigue life, buckling, and crack propogation resulting from static and dynamic loads on the tank and its support.

(b) A three-dimensional analysis of the stress exerted on the tank, its support, and its keys by the hull.

(c) The response of the tank and its support to the vessel's motion and acceleration in irregular waves or calculations from a similar vessel.

(d) A tank buckling analysis considering the maximum construction tolerance.

(e) A finite element analysis using the loads determined under § 154.406.

(f) A fracture mechanics analysis using the loads determined under § 154.406.

(g) The cumulative effects of the fatigue load from the following formula:

$$\Sigma \frac{n_i}{N_i} + \frac{10^3}{N_j} \leq C_w$$

where:

n_i = The number of stress cycles at each stress level during the life of the vessel;
N_i = The number of cycles to failure for corresponding stress levels from the Wohler (S–N) curve;
N_j = The number of cycles to failure from the fatigue load by loading and unloading the tank; and
C_w = 0.5 or less.

§ 154.449 Model test.

The following analyzed data of a model test of structural elements for independent tank type B must be submitted to the Commandant (G–MMT) for special approval:

(a) Stress concentration factors.

(b) Fatigue life.

INDEPENDENT TANK TYPE C AND PROCESS PRESSURE VESSELS

§ 154.450 General.

Independent tanks type C and process pressure vessels must be designed to meet the requirements under Part 54 of this chapter, except § 54.01–40(b) and

(a) The calculation under § 54.01–18 (b)(1) must also include th design loads determined under § 154.406;

(b) The calculated tank plating thickness, including any corrosion allowance, must be the minimum thickness without a negative plate tolerance; and

(c) The minimum tank plating thickness must not be less than—

(1) 5 mm (3/16 in.) for carbon-manganese steel and nickel steel:

(2) 3 mm (1/8 in.) for austenitic steels; or

(3) 7 mm (9/32 in.) for aluminum alloys.

§ 154.451 Design vapor pressure.

The P_o of an independent tank type C must be calculated by the following formula:

$$P_o = 2 + AC(\rho)^{3/2} (kp/cm^2)$$

where:

$$A = 0.0185 \left(\frac{\sigma m}{\Delta \sigma_A}\right)^2$$

σ_m = Design primary stress;
$\Delta\sigma_A$ = (Allowable dynamic membrane stress for double amplitude at probability level $Q = 10^{-8}$) 5.5 kp/mm² (7160 psi) for ferritic and martensitic steels and 2.5 kp/mm² (3580 psi) for 5083–0 aluminum.
C = A characteristic tank dimension that is the greater of h when h is the height of the tank or the dimension in vessel's vertical direction, in meters; $0.75b$ when b is the width of the tank or the dimension in vessel's transverse direction, in meters; or $0.45l$ when l is the length of the tank or the dimension in vessel's longitudinal direction, in meters;
ρ = The specific gravity of cargo.

§ 154.452 External pressure.

The design external pressure for an independent tank type C must be calculated by the following formula:

$$P_e = P_1 + P_2 + P_3 + P_4 (kp/cm^2)$$

where:

P_1=the vacuum relief valve setting for tanks with a vacuum relief valve, or 0.25kp/cm² for tanks without a vacuum relief valve.

P_2=0, or the pressure relief valve setting for an enclosed space containing any portion of a pressure vessel.

P_3=total compressive load in the tank shell from the weight of the tank, including corrosion allowance, weight of insulation, weight of dome, weight of tower and piping, the effect of the partially filled tank, the effect of acceleration and hull deflection, and the local effect of external and internal pressure.

P_4=0, or the external pressure from the head of water from any portion of the pressure vessel on exposed decks.

§ 154.453 Failure to meet independent tank type C standards.

If the Commandant (G–MMT) determines during plan review, that a tank designed as an independent tank type C fails to meet the standards under §§ 154.450, 154.451, and 154.452 and can not be redesigned to meet those standards, the tank may be redesigned as an independent tank type A or B.

SECONDARY BARRIER

§ 154.459 General.

(a) Each tank must have a secondary barrier that meets Table 3.

TABLE 3.—*Secondary barriers for tanks*

Tank type	Cargo temperature at atmospheric pressure		
	−10°C (14°f) and warmer	Colder than −10°C (14°F) to −55°C (−67°F)	Colder than −55°C (−67°F)
Integral	No Secondary barrier required.	Tank type not usually allowed.[1]	Tan type not allowed.
Membrane	do	Complete secondary barrier [1]	Complete secondary barrier.[2]
Semimembrane	do	do [1]	Do.[2]
Independent:			
Type A	do	do [1]	Do.[2]
Type B	do	Partial secondary barrier [1]	Partial secondary barrier.[2]
Type C	do	No secondary barrier required	No secondary barrier required.

[1] The hull may be used as a secondary barrier.
[2] A separate secondary barrier is required.

(b) If the Commandant (G–MNT) specially approves an integral tank for cargoes with a temperature at atmospheric pressures lower than –10° C (14° F), the tank must have a complete secondary barrier that meets § 154.460.

(c) If the Commandant (G–MNT) specially approves a semi-membrane tank under the requirements of an independent tank type B, the semi-membrane tank may have a partial secondary barrier specially approved by the Commandant (G–NMT).

(d) If Table 3 allows the hull to be a secondary barrier, the vessel's hull must—

(1) Meet § 154.600; and

(2) Be designed for the stresses resulting from cargo temperature.

(e) A tank type that is not included in Table 3 must have a secondary barrier that is specially approved by the Commandant (G–NMT).

§ 154.460 Design criteria.

At static angles of heel up through 30°, a secondary barrier must—

(a) Hold any leakage of liquid cargo from the tank for at least 15 days under the loading requirements in § 154.409(e);

(b) If the primary barrier fails, prevent the vessel's structure temperature from falling below the minimum allowable service temperature of the steel; and

(c) Prevent the tank failure from causing a failure in the secondary barrier.

INSULATION

§ 154.465 General.

If the cargo that a vessel carries is below –10° C (14° F), the tank insulation must prevent the temperature of the vessel's hull from cooling below the minimum design temperature allowed under § 154.172.

§ 154.466 Design criteria.

(a) The insulation for a tank without a secondary barrier must be designed for the tank at the temperature of the cargo carried and for a vessel operating in—

(1) Any waters in the world except Alaskan waters for the ambient cold condition of—

(i) Five knots air at –18° C (0° F); and

(ii) Still sea water at 0° C (32° F); or

(2) Alaskan waters for the ambient cold condition of—

(i) Five knots air at 29° C (–20° F); and

(ii) Still sea water at 2° C (28° F).

(b) The insulation for a tank with a secondary barrier must be designed for the secondary barrier at the temperature of the cargo carried and the ambient cold conditions listed under paragraph (a)(1) or paragraph (a)(2) of this section.

(c) The insulation material must be designed for any loads transmitted from adjacent hull structure.

(d) Insulation for tank and piping must meet § 38.05–20 of this chapter.

(e) Powder or granulated insulation must—

(1) Not compact from vibrations of the vessel;

(2) Maintain the thermal conductivity specially approved under § 154.467; and

(3) Not exert a static pressure greater than the external design pressure of the tank under § 154.408.

§ 154.467 Submission of insulation information.

(a) The following insulation information must be submitted to the Commandant (G–MMT):

(1) Compatibility with the cargo.

(2) Solubility in the cargo.

(3) Absorption of the cargo.

(4) Shrinkage.

(5) Aging.

(6) Closed cell content.

(7) Density.

(8) Mechanical properties.

(9) Thermal expansion.

(10) Abrasion.

(11) Cohesion.

(12) Thermal conductivity.

(13) Resistance to vibrations.

(14) Resistance to fire and flame spread.

(15) The manufacturing and installation details of the insulation that includes—

(i) Fabrication; (ii) Storage; (iii) Handling; (iv) Erection; and (v) Quality control.

SUPPORT SYSTEM

§ 154.470 General.

(a) A tank must have a support system that—

(1) Prevents movement of the tank under static and dynamic loads in § 154.406; and

(2) Allows the tank to contract and expand from temperature variation and hull deflection without exceeding the design stress of the tank and the hull.

(b) The tank support system must have a key that prevents rotation of the tank.

(c) An independent tank must have supports with an antiflotation system that withstands the upward force of the tank without deformation of the hull when the tank is—

(1) Empty; and

(2) In a hold space flooded to the summer load draft of the vessel.

§ 154.471 Design criteria.

(a) The tank support system must be designed—

(1) For the loads in § 154.406(a);

(2) To not exceed the allowable stress at a static angle of heel of 30°;

(3) To withstand a collision force equal to at least one-half the weight of the tank and cargo from forward and one-quarter the weight of the tank and cargo from aft; and

(4) For the largest resulting acceleration in Figure 1, including rotational and translation effects.

(b) The tank support design loads in paragraph (a) of this section may be analyzed separately.

§ 154.476 Cargo transfer devices and means.

(a) If a cargo pump in a tank is not accessible for repair when the tank is in use, the tank must have an additional means of cargo transfer, such as another pump or gas pressurization.

(b) If cargo is transferred by gas pressurization, the pressurizing line must have a safety relief valve that is set at less than 90 percent of the tank relief valve setting.

CARGO AND PROCESS PIPING SYSTEMS

§ 154.500 Cargo and process piping standards.

The cargo liquid and vapor piping and process piping systems must meet the

requirements in this subpart and the following subparts and sections in this chapter:

56.01	56.50–105
56.04	56.60
56.07	56.65
56.10	56.70
56.15	56.75
56.20	56.80
56.25	56.85
56.30	56.90
56.35	56.95
56.50–20	56.97

§ 154.503 Piping and piping system components: Protection from movement.

The piping and piping system components and cargo tanks must be protected, where thermal movement and movements of the tank and the hull structure may cause stresses, that exceed the design stresses by—

(a) Offsets; (b) Loops; (c) Bends; (d) Mechanical expansion joints including—

(1) Bellows; (2) Slip joints; or (3) Ball joints; or (e) Other means specially approved by the Commandant (G–MMT).

§ 154.506 Mechanical expansion joint: Limits in a piping system.

The number of mechanical expansion joints in a piping system must be specially approved by the Commandant (G–MMT).

§ 154.508 Mechanical expansion joint: Bellows type.

(a) Mechanical expansion joints in a piping system outside of a cargo tank must be a bellows type.

(b) A bellow expansion joint in a piping system outside of a cargo tank must be protected from icing by—

(1) Insulation;

(2) A cover; or

(3) Other means specially approved by the Commandant (G–MMT).

§ 154.512 Piping: Thermal isolation.

Low temperature piping must be thermally isolated from any adjacent hull structure to prevent the temperature of that structure from dropping below the design temperature of the hull material.

§ 154.514 Piping: Electrical bonding.

(a) Tanks or piping that are separated from the hull structure by thermal isolation must be electrically bonded to the hull structure.

(b) A pipe joint or a hose connection that has a gasket must have an electrical bond.

§ 154.516 Piping: Hull protection.

A vessel's hull must be protected from low temperature liquid leakage by a drip pan, or other means specially approved by the Commandant (G–MMT), at—

(a) Any piping connection dismantled on a routine basis;

(b) Cargo discharge and loading manifold; and

(c) Pump seals.

§ 154.517 Piping: Liquid pressure relief.

The cargo loading and discharge crossover headers, cargo hoses, and cargo loading arms must have means to relieve cargo pressure and to remove liquid cargo.

§ 154.519 Piping relief valves.

(a) The liquid relief valve that protects the cargo piping system from liquid pressure exceeding the design pressure must discharge into a tank.

(b) A liquid relief valve may discharge into a cargo vent mast if that vent mast has a means for the detection and removal of the liquid cargo that is specially approved by the Commandant (G–MMT).

(c) A relief valve on a cargo pump that protects the cargo piping system must discharge into the pump suction.

§ 154.520 Piping calculations.

A piping system must be designed to meet the allowable stress values under § 56.07–10 of this chapter and, if the design temperature is —110° C (—166° F) or lower, the stress analysis must include—

(a) Pipe weight loads;

(b) Acceleration loads;

(c) Internal pressure loads;

(d) Thermal loads; and

(e) Loads from the hull.

§ 154.522 Materials for piping.

(a) The materials for piping systems must meet § 154.625 for the minimum design temperature of the piping, except the material for open ended vent piping may be specially approved by the Commandant (G–MMT) if—

(1) The temperature of the cargo at the pressure relief valve setting is —55° C (—67° F) or warmer; and

(2) Liquid can not discharge to the vent piping.

(b) Materials for piping outside the cargo tanks must have a melting point of at least 925° C (1697° F), except for such short lengths of pipes with fire resisting insulation that are attached to the cargo tanks.

§ 154.524 Piping joints: Welded and screwed couplings.

Pipe lengths without flanges must be joined by a—

(a) Butt welded joint with complete penetration at the weld root, except that for design temperatures colder than —10° C (14° F) the butt weld must be double welded or must have an equivalent to a double welded butt joint by use of—

(1) A backing ring that for design pressures greater than 10 kp/cm² (142 psig) must be removed after the weld is completed;

(2) A consumable insert; or

(3) An inert gas back-up on the first weld pass;

(b) Slip on welded joint with sleeves and attachment welds allowed for an open ended pipe with an external diameter of 50 mm (2 in.) or less and a design temperatures at —55° C (—67° F) or warmer; or

(c) Screwed coupling that meets §§ 56.30–20 and 56.50–105 (a)(4) and (b)(4) of this chapter.

§ 154.526 Piping joints: Flange connection.

Flange connections for pipe joints must meet §§ 56.30–10 and 56.60–105 (a)(4) and (b)(4) of this chapter.

§ 154.528 Piping joints: Flange type.

(a) A flange must be one of the following types:

(1) Welding neck.

(2) Slip-on.

(3) Socket weld.

(b) If the design temperature of the piping is between —10° C (14° F) and —55° C (—67° F), the pipe flange may be a—

(1) Slip-on type, if the nominal pipe size is less than 100 mm (4 in.);

(2) Socket weld, if the nominal pipe size is less than 50 mm (2 in.); or

(3) Welding neck.

(c) If the design temperature of the piping is lower than —55° C (—67° F), the pipe flange must be a welding neck type.

§ 154.530 Valves: Cargo tank MARVS 0.7 kp/cm² (10 psig) or lower.

(a) Liquid and vapor connections on a cargo tank with a MARVS of 0.7 kp/cm² (10 psig) or lower, except connections for safety relief valves and liquid level gauging devices, must have shut-off valves that—

(1) Close;

(2) Are located as close to the tank as practicable; and

(3) Have manual control at the valve.

(b) The cargo piping system for a cargo tank with a MARVS of 0.7 kp/cm² (10 psig) or lower must have at least one remotely controlled quick closing shut-off valve for closing liquid and vapor piping between vessel and shore that meets §§ 154.540, 154.542, and 154.544.

§ 154.532 Valves: Cargo tank MARVS greater than 0.7 kp/cm² (10 psig).

(a) Liquid and vapor connections on a cargo tank with a MARVS greater than 0.7 kp/cm² (10 psig), except connections for safety relief valves and liquid level gauging devices, must have as close to the tank as practicable, a—

(1) Manual controlled stop valve; and

(2) Remotely controlled quick-closing shut-off valve.

(b) If the nominal pipe size of a liquid or vapor connection is less than 50 mm (2 in.), an excess flow valve may be substituted for the quick closing valve required under paragraph (a) of this section.

(c) A single valve may be substituted for the manual controlled stop valve and the remotely controlled quick-closing shut-off valve required under paragraph (a) of the section if that single valve—

(1) Meets §§ 154.540, 154.542, and 154.544; and

(2) Is also manually controlled.

§ 154.534 Cargo pumps and compressors.

Cargo pumps and compressors must shut down automatcially when the quick-closing shunt-off valves required under §§ 154.530 and 154.532 are closed by the

emergency shut-down system required under § 154.540.

§ 154.536 Tank gauging and measuring connections.

Unless the outward flow from a tank is less than the flow through a circular hole of 1.4 mm (.055 in.), in diameter, tank connections for gauging or measuring devices must have excess flow or quick-closing shut-off valves.

§ 154.538 Cargo transfer connection.

A cargo transfer connection must have a—

(a) Remotely controlled quick-closing shut-off valve; or

(b) Blank flange.

§ 154.540 Quick-closing shut-off valves: Emergency control system.

(a) The remotely controlled quick-closing shut-off valve required under §§ 154.530, 154.532, and 154.538 must have an emergency control system to operate the valve.

(b) The control system required under paragraph (a) of this section must be in—

(1) The cargo control station; and

(2) At least one other remote location on the vessel.

(c) The quick-closing shut-off valve required under §§ 154.530, 154.532, and 154.538 must—

(1) Be the fail-closed type; and

(2) Have manual control.

§ 154.542 Quick-closing shut-off valves: Emergency control system fusible elements.

The control system required under § 154.540 must have fusible elements at each tank dome and cargo loading and discharge manifold that melt between 98° C (208° F) and 104° C (220° F) and close the quick-closing shut-off valves.

§ 154.544 Quick-closing shut-off valves: Closing time.

A quick-closing shut-off valve in liquid cargo piping must close from the open position in at least 30 seconds or less.

§ 154.546 Excess flow valve: Closing flow.

(a) The rated closing flow of vapor or liquid cargo for an excess flow valve must be specially approved by the Commandant (G–MMT).

(b) An excess flow valve allowed under § 154.532 must close automatically at the rated closing flow.

§ 154.548 Cargo piping: Flow capacity.

Piping with an excess flow valve must have a vapor or liquid flow capacity that is greater than the rated closing flow required under § 154.546.

§ 154.550 Excess flow valve: Bypass.

An excess flow valve allowed under § 154.532(b) may have a bypass of 1.0 mm (.0394 in.) or less in diameter.

§ 154.552 Liquid and vapor cargo hose: Compatibility.

Liquid and vapor cargo hoses must—

(a) Not chemically react with the cargo; and

(b) Withstand cargo temperature.

§ 154.554 Cargo hose: Bursting pressure.

Cargo hose that can be pressurized by the tank, the cargo pump discharge, or the vapor compressor discharge must have a bursting pressure of at least five times the maximum working pressure on the hose during cargo transfer.

§ 154.556 Cargo hose: Maximum working pressure.

A cargo hose must have a maximum working pressure not less than the maximum pressure to which it may be subjected and at least 10.5 kp/cm^2 (150 psig).

§ 154.558 Cargo hose: Marking.

Each cargo hose must be marked with the—

(a) Maximum working pressure; and

(b) Minimum service temperature for service at other than ambient temperature.

§ 154.560 Cargo hose: Prototype test.

Each cargo hose must be of a type that passes a prototype test at a pressure of at least five times its maximum working pressure to at least the service temperature.

§ 154.562 Cargo hose: Hydrostatic test.

Each cargo hose must pass a hydrostatic pressure test of at least 1.5 times its specified maximum working pressure but not more than two-fifths its bursting pressure and at ambient temperature.

MATERIALS

§ 154.605 Toughness test.

(a) Each toughness test for material used to meet the requirements of §§ 154.610 through 154.625 must meet Subpart 54.05 of this chapter.

(b) The Charpy V-notch energy for subsize toughness test specimens must meet Table 56.50–105(a) of this chapter.

§ 154.610 Design temperature not colder than 0° C (32° F).

(a) Plates, pipes, tubes, forgings, forged and rolled fittings, rolled and forged bars and shapes, and castings used in the construction of tanks and process pressure vessels for a design temperature not colder than 0° C (32° F) must be carbon manganese steel, made with fine grain practice, austenitic grain size of five or finer where the thickness exceeds 20 mm (.787 in.), and normalized or quenched and tempered. A control rolling procedure may be substituted for normalizing if specially approved by the Commandant (G–MMT). Plate for an independent tank type C and process pressure vessel must also meet the requirements of ASTM A–20 and § 54.01–18 (b) (5) of this chapter.

(b) A recognized classification society's grades D, up to 20 mm (.787 in.), and E hull structural steel may be used for an independent type A tank if the steel is tested under § 54.05–10 of this chapter.

(c) A tensile test must be made for—

(i) Each plate as rolled; and

(ii) Each five short ton batch of forgings, forged or rolled fittings, rolled or forged bars and shapes, and castings.

(d) The minimum specified yield stress must not exceed 65 kp/mm^2 (92.43 Ksi) and when it exceeds 50 kp/mm^2 (71.10 Ksi) the hardness of the weld and heat affected zone must be specially approved by the Commandant (G–MMT).

(e) A Charpy V-notch test must be made for—

(1) Each plate as rolled; and

(2) Each five short ton batch of forgings, forged or rolled fittings, rolled or forged bars and shapes, and castings.

(f) The orientation and required impact energy of a 10 mm x 10 mm (.394 in. x .394 in.) Charpy V-notch specimen is as follows:

(1) Plate, transverse specimen, 2.8 kpm (20 ft-lbs).

(2) Forgings, forged and rolled fittings, rolled and forged bars and castings, longitudinal specimen, 4.2 kpm (30 ft-lbs).

(g) The test temperature of the Charpy V-notch specimens is as follows:

MATERIAL THICKNESS AND TEST TEMPERATURE

$t \leq 20$ mm (.788 in.), 0° C (32° F)
$20 < t \leq 30$ mm (1.182 in.), −20° C (−4° F)
$30 < t \leq 40$ mm (1..576 in.) −40° C (−40° F)

§ 154.615 Design temperature below 0° C (32° F) and down to −55° C (−67° F).

Plates, forgings, forged or rolled fittings, rolled or forged bars and shapes, and castings for tanks, secondary barriers, and process pressure vessels with a design temperature below 0° C (32° F) and down to −55° C (−67° F) must meet the material requirements in § 54.25–10 of this chapter.

§ 154.620 Design temperature below −55° C (−67° F) and down to −165° C (−265° F).

Plates, forgings and forged or rolled fittings, rolled or forged bars and shapes, and castings for tanks, secondary barriers, and process pressure vessels with a design temperature below −55° C (−67° F) and down to −165° C (−265° F) must meet § 54.25–10(b)(2), § 54.25–15, or § 54.25–20 of this chapter.

§ 154.625 Design temperature below 0° C (32° F) and down to −165° C (−265° F).

Pipes, tubes, forgings, castings, bolting, and nuts for cargo process piping with a design temperature below 0° C (32° F) and down to −165° C (−265° F) must meet § 56.50–105 of this chapter.

§ 154.630 Tank material.

(a) If a material of a tank is not listed in §§ 154.610, 154.615 or 154.620, the allowable stress of that material must be specially approved by the Commandant (G–MMT).

(b) Material in the area of welded connections in aluminum alloys must have the tensile strength of the annealed condition.

(c) Increased yield stress and tensile strength of a material at low tempera-

ture for independent tanks type A, B and C must be specially approved by the Commandant (G–MMT).

CONSTRUCTION

§ 154.650 Tank and process pressure vessel welding.

(a) Tank and process pressure vessel welding must meet Subpart 54.05 and Part 57 of this chapter.

(b) Welding consumables for welding tanks must meet §57.02–4 of this chapter.

(c) For independent tanks—

(1) Each welded joint of the shells must be a full penetration butt weld, except that full penetration tee welds may be used for dome to shell connections; and

(2) Each nozzle weld must be of the full penetration type, except for small penetrations on domes.

(d) For independent tanks type C and process pressure vessels, each welded joint must meet Part 54 of this chapter, except that any backing rings must be removed unless specially approved by the Commandant (G–MMT).

(e) For each welded joint in a membrane tank, the quality assurance measures, weld procedure qualification, design details, materials, construction, inspection, and production testing of components must meet the standards developed during the prototype testing program that are specially approved by the Commandant (G–MMT).

(f) For semi-membrane tanks, each welded joint must meet paragraph (c) or (e) of this section.

§ 154.655 Stress relief for independent tanks type C.

For a design temperature colder than −10° C (14° F), an independent tank type C of —

(a) Carbon and carbon-manganese steel must be stress relieved by post-weld heat treatment under § 54.25–7 of this chapter or mechanical stress relief under Subpart 54.30; or

(b) Materials other than carbon and carbon manganese steel must be stress relieved using a procedure specially approved by the Commandant (G–MMT).

§ 154.660 Pipe welding.

(a) Pipe welding must meet Part 57 of this chapter.

(b) Butt welds of pipes made from carbon, carbon manganese, or low alloy steels must be post-weld heat treated and must meet § 56.50–105 and Subpart 56.85 of this chapter.

(c) In addition to normal controls before and during the welding and to the visual inspection of the finished welds, the following tests are required as necessary for proving that the welding has been carried out correctly:

(1) A piping system with a service temperature lower than −10° C (14° F) and a wall thickness greater than 10 mm (.394 in.) or with an inside diameter greater than 100 mm (4 in.) must have 100 percent radiographic testing for butt welded joints.

(2) When Table 4 references this section, butt welded joints for deck cargo piping exceeding 75 mm (3 in.) in diameter must be 100 percent radiographic tested.

(3) For other butt welded joints of pipes, the non-destructive testing must meet Subpart 56.95 of this chapter.

§ 156.665 Welding procedures.

Welding procedure tests for tanks with a design temperature colder than 0° C (32° F), process pressure vessels, and piping must meet § 54.05–15 and Subpart 57.06 of this chapter.

CARGO PRESSURE AND TEMPERATURE CONTROL

§ 154.701 Cargo pressure and temperature control: General.

(a) Each refrigeration system must—(LNG) tank, must—

(1) Have a refrigeration system that meets § 154.702; or

(2) Be an independent tank type C having a P_o greater than the vapor pressure of the cargo at 45° C (113° F).

(b) The vessel must have a separate refrigeration system for each refrigerated incompatible cargo.

§ 154.702 Refrigerated carriage.

(a) Each refrigerated system must—

(1) Have enough capacity to maintain the cargo pressure below P_o under ambient design temperatures of 45° C (113° F) still air and 32° C (89.6° F) still water with the largest unit in the system inoperative; or

(2) Have a standby unit with a capacity at least equal to the capacity of the largest refrigeration unit operating in the system.

(b) For the purpose of this section, a "refrigeration unit" includes a compressor and its motors and controls.

(c) Each refrigeration system must—

(1) Have a heat exchanger with an excess capacity of 25 percent; or

(2) A standby heat exchanger.

(d) Where cooling water is used in a refrigeration system—

(1) The cooling water pump or pumps must be used exclusively for the system;

(2) Each pump must have suction lines from seachests on the port and starboard sides of the vessel; and

(3) The vessel must have a standby pump, which may be a pump that is used for other, non-essential purposes.

(e) Each refrigeration system must use refrigerants that are compatible with the cargo and, for cascade units, with each other.

(f) Each refrigeration system must have automatic and manual cargo temperature controls.

(g) The pressure of the heat transfer fluid in each cooling coil in a tank must be greater than the pressure of the cargo.

§ 154.703 Methane (LNG).

Unless a tank carrying methane (LNG) can withstand the pressure build up due to boil-off for 21 days, the pressure in the tank must be maintained below P_o for at least 21 days by—

(a) A refrigeration system that meets § 154.702;

(b) Burning boil-off gas in a waste heat or catalytic furnace that—

(1) Maintains the stack exhaust temperature below 535° C (995° F);

(2) Exhibits no visible flame; and

(3) Is specially approved by the Commandant (G–MMT); or

(c) Using the boil-off gas as fuel in boilers, inert gas generators, and combustion engines in the main propelling machinery space or for other services and in other spaces specifically approved by the Commandant (G–MMT).

§ 154.705 Cargo boil-off as fuel: General.

(a) Each cargo boil-off fuel system used to meet § 154.703(c) must meet §§ 154.706 through 154.709.

(b) The piping must have a connection for introducing inert gas and gas freeing the piping in the machinery space.

(c) A gas fired main propulsion boiler or combustion engine must have a fuel oil fired pilot to maintain fuel flow if gas fuel supply is cut off.

§ 154.706 Cargo boil-off as fuel: Fuel lines.

(a) Gas fuel lines must not pass through accommodation, service, or control spaces. A gas line passing through other spaces must meet one of the following:

(1) The fuel line must be a double-walled piping system with the annular space containing an inert gas at a pressure greater than the fuel pressure. Visual and audible alarms must be installed at the machinery control station to indicate loss of inert gas pressure.

(2) The fuel line must be installed in a mechanically exhaust ventilated pipe or duct, having a rate of air change of at least 30 changes per hour. The pressure in the space between the inner pipe and outer pipe or duct must be maintained at less than atmospheric pressure. If the required air flow is not established or maintained, the gas fuel supply must be automatically shut off. Continuous gas detection must be installed in the ventilated space to detect leaks and to automatically shut off the gas fuel supply to meet § 154.708(c). The ventilation system must meet the requirements of § 154.1205.

(b) Each double wall pipe or vent duct must terminate in the ventilation hood or casing required under § 154.707(a). Continuous gas detection must be installed in the hood or casing to indicate leaks and to shut off the gas fuel supply to meet paragraph (a)(2) of this section.

§ 154.707 Cargo boil-off as fuel: Ventilation.

(a) A ventilation hood or casing must be installed in areas occupied by flanges, valves, and piping at the fuel burner to cause air to sweep across them and be exhausted at the top of the hood or casing.

(b) The hood or casing must be mechanically exhaust ventilated and meet § 154.1205.

(c) If the air flow in the ventilated hood or casing falls below the rate specially approved by the Commandant (G-MMT), the gas fuel supply must be shut off.

§ 154.708 Cargo boil-off as fuel: Valves.

(a) Gas fuel lines to the gas consuming equipment must have two fail-closed automatic valves in series. A third valve, designed to fail-open, must vent that portion of pipe between the two series valves to the open atmosphere.

(b) These valves must be arranged so that loss of boiler forced draft, flame failure, or abnormal gas fuel supply pressure automatically causes the two series valves to close and the vent valve to open. The function of one of the series valves and the vent valve may be performed by a single three-way valve.

(c) A master gas fuel valve must be outside the machinery space, but be operable from inside the machinery space and at the valve. The valve must automatically close if leakage of gas or loss of ventilation is detected.

§ 154.709 Cargo boil-off as fuel: Gas detection equipment.

(a) The continuous gas detection system required under § 154.706 (a) (2) and (b) must—

(1) Meet § 154.1350 of this part; and

(2) Have a device that activates an audible and visual alarm at the machinery control station and in the wheelhouse if the concentration reaches 1.5 percent by volume of methane and closes the master gas fuel valve required under § 154.708(c) if the concentration reaches 3 percent by volume.

(b) The number and arrangement of gas sampling points must be specially approved by the Commandant (G-MMT).

CARGO VENT SYSTEMS

§ 154.801 Pressure relief systems.

(a) Each tank that has a volume of 20 m^3 (706 $ft.^3$) or less must have at least one pressure relief valve.

(b) Each tank that has a volume of greater than 20 m^3 (706 $ft.^3$) must have at least two pressure relief valves of equal relieving capacity.

(c) Each pressure relief valve must—

(1) Meet 46 CFR 162.018 or, if the MARVS is 0.7 kp/cm^2 (10 psig) or less, 46 CFR 162.017, and have at least the capacity required under § 154.806;

(2) Not be set for a higher pressure than the MARVS;

(3) Have a fitting for sealing wire that prevents the set relieving pressure from being changed without breaking the sealing wire;

(4) Be insulated from the tank if the temperature of the cargo carried is below 0° C (32° F);

(5) Be fitted on the tank to remain in the vapor phase under conditions of 15° list and 0.015 L trim;

(6) Vent to a vent mast under § 154.805, except a relief valve may vent to a common tank relief valve header if the back pressure is taken into account in determining the required capacity in § 154.806;

(7) Not vent to a common header or common vent mast if the relief valves are connected to tanks carrying chemically imcompatible cargoes; and

(8) Not have any stop valves or other means of isolating the tank from its relief valve unless—

(i) The stop valves are interlocked or arranged so that only one pressure relief valve is out of service at any one time;

(ii) The interlock arrangement automatically shows the relief valve that is out of service; and

(iii) The remaining valves have the relieving capacity required under § 154.806, or all valves on the tank are the same size and a spare is carried, or a spare is carried for each valve on a tank.

§ 154.802 Alternate pressure relief settings.

Tanks specially approved for more than one relief valve setting must have one of the following valve arrangements:

(a) Valves that—

(1) Are set and sealed under § 154.801(c);

(2) Have the capacity required under § 154.806; and

(3) Are interlocked so that all relief valves cannot be isolated from the tank at any time.

(b) Valves that have spacer pieces or springs that—

(1) Change the set pressure without pressure testing to verify the new setting; and

(2) Can be installed without breaking the sealing wire required under § 154.801(c)(3).

§ 154.804 Vacuum protection.

(a) Each cargo tank must have—

(1) A pressure switch that operates an audible and visual alarm in the wheelhouse and cargo control station at or below 80 percent of the maximum external design pressure differential of the cargo tanks and a second, independent pressure switch that automatically shuts off all suction of cargo liquid or vapor from the cargo tank and secures any refrigeration of that tank at or below the maximum external designed pressure differential; or

(2) A vacuum relief valve that—

(i) Has a gas flow capacity at least equal to the maximum cargo discharge rate per tank;

(ii) Is set to open at or below the maximum external designed pressure differential;

(iii) Admits inert gas, cargo vapor from a source other than a cargo vapor header, or air except as prohibited under § 154.1710.

(b) Each vacuum protection system must have a means to test its operation.

(c) Tanks designed to withstand a maximum external pressure differential exceeding 0.25 kp/cm^2 (3.55 psig) and to withstand the maximum external pressure differential that can be attained at maximum discharge rates with no vapor return to the cargo tanks, by operation of a cargo refrigeration system, or by drawing off vapors for use in accordance with § 154.703(c), are not required to have vacuum protection.

§ 154.805 Vent masts.

Relief vents or common vent headers from relief valves must discharge to a vent mast that—

(a) Discharges vertically upward;

(b) Has a rain cap or other means of preventing the entrance of rain or snow;

(c) Has a screen or bars not more than 25 mm (1 in.) apart;

(d) Extends at least to a height of B/3 or 6 m (19.7 ft.), whichever is greater, above the weather deck and 6 m (19.7 ft.) above the working level;

(e) On a tank, does not exhaust within a radius of *B* or 25 m (82 ft.), whichever is less, from any forced or natural ventilation intake or other opening to an accommodation, service, control station, or other gas-safe space;

(f) On a containment system, except a tank, does not exhaust within a radius of 10 m (32.8 ft.) or less from any forced or natural ventilation intake or other opening to an accommodation, service, control station, or other gas-safe space;

(g) Has drains to remove any liquid that may accumulate; and

(h) That prevents accumulations of liquid at the relief valves.

§ 154.806 Capacity of pressure relief valves.

Pressure relief valves for each tank must have a combined relief capacity, considering back pressure from vent piping, headers, and masts, to discharge the greater of the following with not more than a 20 percent rise in cargo tank pressure above the MARVS:

(a) The maximum capacity of an installed tank inerting system.

(b) Quantity of vapors generated from fire exposure that is calculated under § 54.15-25 of this chapter.

ATMOSPHERIC CONTROL IN CARGO CONTAINMENT SYSTEMS

§ 154.901 Atmospheric control within cargo tanks and cargo piping systems.

(a) Each vessel must have a piping system for gas freeing and purging of each tank and all cargo piping.

(b) The piping system must minimize the pocketing of gas or air remaining after purging.

(c) For tanks certificated to carry flammable gases, the piping system must allow purging the tank of flammable vapors before air is introduced and purging the tank of air before the tank is filled with cargo.

(d) Each cargo tank must have—

(1) Gas sampling points at the top, middle, and bottom of the tanks; and

(2) Gas sampling line connections that are valved and capped above the deck.

§ 154.902 Atmospheric control within hold and interbarrier spaces.

(a) Vessels certificated to carry flammable cargo in cargo containment systems with full secondary barriers must have an inert gas system or onboard storage of inert gas that provides enough inert gas to meet the requirements of § 154.1848 for 30 days consumption.

(b) Vessels certificated to carry flammable cargo in cargo containment systems with partial secondary barriers must—

(1) Have an inert gas system or onboard inert gas storage that can inert the largest hold and interbarrier space;

(2) Have a gas detection system for each hold and interbarrier space; and

(3) Meet the requirements of § 154.902(a) or § 154.902(c)(2).

(c) Vessels certificated to carry only non-flammable cargo in cargo containment systems with secondary barriers must—

(1) Meet the requirements of § 154.902(a); or

(2) Have air drying systems that reduce the dewpoint of any air admitted to hold or interbarrier spaces below the temperature of any surface in those spaces.

(d) Vessels with refrigerated independent tanks type C must have inert gas or air drying systems that reduce the dewpoint of any inert gas or air admitted to the hold spaces below the temperature of any surface in the hold spaces.

§ 154.903 Inert gas systems: general.

(a) Inert gas carried or generated to meet §§ 154.901, 154.902, and 154.1848 must be non-flammable and non-reactive with the cargoes that the vessel is certificated to carry and the materials of construction of the tanks, hold and interbarrier spaces, and insulation.

(b) The boiling point and dewpoint at atmospheric pressure of the inert gas must be lower than the temperature of any surface in the spaces that the gas inerts.

(c) Storage vessels and inert gas piping must meet §§ 154.400 and 154.500 for the temperatures and pressures at which the gas is stored and used.

§ 154.904 Inert gas system: Controls.

The inert gas system must have—

(a) At least two check valves, or other means specially approved by the Commandant (G–MMT), in the cargo area to prevent the back flow of cargo vapor into the inert gas system;

(b) Automatic and manual inert gas pressure controls; and

(c) Valves to isolate each inerted space.

§ 154.906 Inert gas generators.

The inert gas generator must—

(a) Produce an inert gas containing less than 5 percent oxygen;

(b) Have a device to continuously sample the discharge of the generator for oxygen content; and

(c) An audible and visual alarm in the cargo control station set at or below 5 percent oxygen by volume.

§ 154.908 Inert gas generator: Location.

(a) Except as allowed in paragraph (b) of this section, an inert gas generator must be located in a space that is not in the cargo area and does not have direct access to any accommodation, service, or control space.

(b) An inert gas generator that does not use flame burning equipment may be located in the cargo area if specially approved by the Commandant (G–MMT).

§ 154.910 Inert gas piping: Location.

Inert gas piping must not pass through or terminate in an accommodation, service, or control space.

§ 154.912 Inerted spaces: Relief devices.

Inerted spaces must be fitted with relief valves, rupture discs, or other devices specially approved by the Commandant (G–MMT).

ELECTRICAL

§ 154.1000 Applicability.

(a) Sections 154.1005 through 154.1020 apply to flammable cargo and ammonia carriers.

(b) For the purposes of §§ 154.1005 through 154.1020, an ammonia carrier is not gas-dangerous on the open deck.

§ 154.1005 Equipment approval.

(a) All electrical equipment that is required to be intrinsically safe or explosion-proof under § 154.1010 must be approved or listed by an independent laboratory that is specially approved by the Commandant (G–MMT), such as Underwriters' Laboratories, Inc. or Factory Mutual Systems, for Class I Division I locations and the Group that is specified in Table 4 for the cargo carried.

(b) Each submerged cargo pump motor installation must be specially approved by the Commandant (G–MMT).

(c) All electrical equipment that must be intrinsically safe to meet § 154.1010 must meet the definition in § 110.15–100 (i) of this chapter.

(d) All electrical equipment that must be explosion-proof to meet § 154.1010 must meet § 110.15–65(e) of this chapter.

§ 154.1010 Electrical equipment in gas dangerous space or zone.

(a) Except as allowed in this section, electrical equipment must not be installed in a gas dangerous space or zone.

(b) Intrinsically safe electrical equipment and wiring may be in a gas dangerous space or zone.

(c) A submerged cargo pump motor may be in any tank if—

(1) Low liquid level, motor current, or pump discharge pressure automatically shuts down power to the pump motor if the pump loses suction;

(2) There is an audible and visual alarm at the cargo control station that actuates if the motor shuts down under the requirements of subparagraph (1) of this paragraph; and

(3) There is a lockable circuit breaker or lockable switch that disconnects the power to the motor.

(d) A supply cable for a submerged cargo pump motor may be in a hold space.

(e) A hold space that has a tank that is not required to have a secondary barrier under § 154.459 may have—

(1) Through runs of cable;

(2) Explosion-proof lighting fixtures;

(3) Depth sounding devices in gas tight enclosures;

(4) Log devices in gas tight enclosures; and

(5) Impressed current cathodic protection system electrodes in gas tight enclosures.

(f) A space that is separated by a gas tight steel boundary from a hold space that has a tank that must have a secondary barrier under the requirements of § 154.459 may have—

(1) Through runs of cable;

(2) Explosion-proof lighting fixtures;

(3) Depth sounding devices in gas tight enclosures;

(4) Log devices in gastight enclosures;

(5) Impressed current cathodic protection system electrodes in gastight enclosures;

(6) Explosion-proof motors that operate cargo system valves or ballast system valves; and

(7) Explosion-proof bells for general alarm systems.

(g) A cargo handling room may have—

(1) Explosion-proof lighting fixtures; and

(2) Explosion-proof bells for general alarm systems.

(h) A space for cargo hose storage may have—

(1) Explosion-proof lighting fixtures; and

(2) Through runs of cable.

(i) A space that has cargo piping may have—

(1) Explosion-proof lighting fixtures; and

(2) Through runs of cable.

(j) A zone on the open deck may have—

(1) Explosion-proof equipment that is necessary for the operation of the vessel; and

(2) Through runs of cable.

(k) A space, except those named in paragraph (e) through (j) of this section, that has a direct opening to gas-dangerous space or zone may only have the electrical equipment allowed in the gas-dangerous space or zone.

§ 154.1015 Lighting in gas-dangerous space.

(a) Each gas-dangerous space that has lighting fixtures must have at least two branch circuits for lighting.

(b) Each switch and each overcurrent protective device for any lighting circuit that is in a gas-dangerous space must open each conductor of the circuit simultaneously.

(c) Each switch and each overcurrent protective device for lighting in a gas-

dangerous space must be in a gas safe space.

§ 154.1020 Emergency power.

The emergency generator must be designed to allow operation at the final angle of heel under § 154.230(a).

FIREFIGHTING

§ 154.1100 Firefighting: General.

Each vessel must meet Parts 32 and 34 of this chapter.

FIREFIGHTING SYSTEM: EXTERIOR WATER SPRAY

§ 154.1105 Exterior water spray system: General.

Each flammable liquefied gas carrier and each toxic liquefied gas carrier must have an exterior water spray system that meets §§ 154.1110 through 154.1135.

§ 154.1110 Areas protected by system.

Each water spray system must protect the following:

(a) All parts of each tank that are not covered by the vessel's hull structure or a steel cover, including the dome.

(b) Each on-deck storage vessel for flammable or toxic liquefied gases.

(c) Each cargo discharge and loading manifold.

(d) Each quick closing valve required by §§ 154.530, 154.532, and 154.538, and other control valves.

(e) Each boundary facing the cargo area of each superstructure that contains accommodation, service, or control spaces.

(f) Each boundary facing the cargo area of each deckhouse that contains accommodation, service, or control spaces.

(g) Each boundary of each deckhouse that is within the cargo area and that is manned during navigation of the vessel or during cargo transfer operations, except the deckhouse roof if it is 2.4 m (8 ft.) or higher above the main deck.

§ 154.1115 Discharge.

(a) Each water spray system must discharge at least—

(1) 10 l/m^2/min. (.25 gpm/$ft.^2$) over each horizontal surface; and

(2) 4 l/m^2/min. (.10 gpm/$ft.^2$) against each vertical surface, including water rundown if the vertical distance from the nozzles to the protected area does not exceed 3.7 m (12 ft.).

(b) The area of water spray coverage required under § 154.1110(c) and (d) for fittings and valves must be an area in a horizontal plane extending at least .5 m (19 in.) in each direction from the pipes, fittings, and valves, or the area of the drip tray, whichever is greater.

§ 154.1120 Nozzles.

Nozzles for the water spray system must be spaced to discharge the minimum density required under § 154.1115 over each part of the protected area.

§ 154.1125 Pipes, fittings, and valves.

(a) Each pipe, fitting, and valve for each water spray system must meet Part 56 of this chapter.

(b) Each water spray main that protects more than one area listed in § 154.1110 must have at least one isolation valve at each branch connection and at least one isolation valve downstream of each branch connection.

(c) Each valved cross-connection from the water spray system to the fire main must be outside of the cargo area.

(d) Each distribution piping system must be made of fire resistant and corrosion resistant materials, such as galvanized steel or galvanized iron pipe.

(e) Each water spray system must have drains, strainers, and dirt traps.

§ 154.1130 Sections.

(a) If a water spray system is divided into sections, each section must at least include all of the area of an athwartship tank grouping.

(b) If a water spray system is divided into sections, the control valves must be at a single manifold that is aft of the cargo area.

§ 154.1135 Pumps.

(a) Water to the water spray system must be supplied by—

(1) A pump that is only for use on the system;

(2) A fire pump; or

(3) Another pump specially approved by the Commandant (G-MMT).

(b) Operation of a water spray system must not interfere with simultaneous operation of the fire main system at its required capacity.

(c) Except as allowed under paragraph (d) of this section, each pump for each water spray system must have the capacity to simultaneously supply all areas named in § 154.1110.

(d) If the water spray system is divided into sections, the pump must have the capacity to simultaneously supply—

(1) All the areas in § 154.1110(c) through (g); and

(2) The largest section that includes any area listed in § 154.1110(a) and (b).

FIREFIGHTING SYSTEM: DRY CHEMICAL

§ 154.1140 Dry chemical system: General.

(a) Each liquefied flammable gas carrier must have a dry chemical firefighting system that meets §§ 154.1145 through 154.1170 and Part 56 and § 162.039 of this chapter.

(b) The plans for the dry chemical supply and distribution systems, including all controls, must be submitted under Subpart 50.20 of this chapter.

§ 154.1145 Dry chemical supply.

(a) A vessel with a cargo carrying capacity less than 1000 m^3 (35,300 $ft.^3$) must have at least one self-contained dry chemical unit for the cargo area with independent inert gas pressuring sources adjacent to the unit.

(b) A vessel with a cargo carrying capacity of 1000 m^3 (35,300 $ft.^3$) or more must have at least two self-contained dry chemical storage units for the cargo area with independent inert gas pressurizing sources adjacent to each unit.

(c) Each dry chemical system must have at least one self-contained dry chemical storage unit and independent inert gas pressurizing source for each bow and stern loading and discharge area.

(d) Each hose line and monitor of each dry chemical system that is attached to a single storage unit must operate sequentially for 45 seconds each and simultaneously for 45 seconds.

§ 154.1150 Distribution of dry chemical.

(a) All of the above deck cargo area and all cargo piping outside that cargo area must be protected by—

(1) At least two dry chemical hand hose lines that have separate dry chemical supplies; or

(2) At least one dry chemical hand hose line and one dry chemical monitor that have separate dry chemical supplies.

(b) At least one dry chemical storage unit and hand hose line or monitor must be at the after end of the cargo area and all other gas dangerous areas except stern loading areas.

(c) Each part of the cargo area must be protected by at least one dry chemical hand hose line that is aft of that part or at least one dry chemical monitor that is aft of that part.

(d) Each cargo loading and discharge manifold must be protected by at least one dry chemical monitor.

(e) Each bow loading area and each stern loading area must also be protected by at least one hand hose line.

§ 154.1155 Hand hose line coverage.

For the purposes of § 154.1150, the coverage for an area protected by each hand hose line is equal to its length, except the coverage for the protection of areas that are inaccessible to personnel is equal to one-half the projection of the hose at its rated discharge, or 10 m (33 ft.), whichever is less.

§ 154.1160 Monitor coverage of system.

For the purposes of § 154.1150, the allowed coverage of each dry chemical system monitor must not exceed—

(a) 10 m (32.8 ft.) at 10 kg/sec (22 lb/sec);

(b) 30 m (984 ft.) at 25 kg/sec (55 lb/sec);

(c) 40 m (131.2 ft.) at 45 kg/sec (99/lb sec);

(d) An interpolation between 10 m (32.8 ft.) at 10 kg/sec (22 lb/sec) and 30 m (98.4 ft.) at 25 kg/sec (55 lb/sec);

(e) An interpolation between 30 m (98.4 ft.) at 25 kg/sec (55 lb/sec) and 40 m (131.2 ft.) at 45 kg/sec (99 lb/sec); or

(f) An extrapolation of 40 m (131.2 ft.) at 45 kg/sec (99 lb/sec).

§ 154.1165 Controls.

(a) Each dry chemical hand hose line must be one that can be actuated at its hose reel.

(b) Each dry chemical monitor must be one that can be—

(1) Actuated and controlled at the monitor; and

(2) Actuated and controlled at a location away from the monitor and the protected area, except a monitor that is pre-aimed at the manifold does not have to be controlled at a location away from the monitor and the protected area.

(c) Each dry chemical storage unit that has more than one hand hose line, monitor, or combination of hand hose line and monitor must have independent piping with a stop valve for each hand hose line or monitor, where it connects to the storage container.

(d) Each stop valve for a hose reel or monitor must have a remote control at the hose reel or monitor.

(e) Damage to any dry chemical system hose reel, monitor, pipe or control circuit must not prevent the operation of other hose reels, monitors, or control circuits that are connected to the same storage unit.

§ 154.1170 Hand hose line: General.

Each dry chemical hand hose line must—

(a) Be 33 m (108 ft.) long or less;

(b) Be operable whether or not it is unwound from a hose reel or removed from a hose cabinet;

(c) Be without kinks;

(d) Have a nozzle with a valve to start and stop the flow of chemical;

(e) Have a capacity of at least 3.5 kg/sec (7.7 lb./sec); and

(f) Be one that can be operated by one person.

CARGO AREA: MECHANICAL VENTILATION SYSTEM

§ 154.1200 Mechanical ventilation system: General.

(a) Each cargo compressor room, pump room, gas dangerous cargo control station, and space that contains cargo handling equipment must have a fixed, exhaust type, mechanical ventilation system.

(b) The following spaces must have a supply type mechanical ventilation system:

(1) Each space that contains electric motors for cargo handling equipment.

(2) Each gas-safe cargo control station.

(3) Each gas-safe space in the cargo area.

(4) Each space that contains inert gas generators, except main machinery spaces.

§ 154.1205 Mechanical ventilation system: Standards.

(a) Each exhaust type mechanical ventilation system required under § 154.1200(a) must have ducts for vapors from the following.

(1) The deck level.

(2) Bilges.

(3) If the vapors are lighter than air, the top of each space that personnel enter during cargo handling operations.

(b) The discharge end of each duct must be at least 10 m (32.8 ft.) from ventilation intakes and openings to accommodation, service, control station, and other gas-safe spaces.

(c) Each ventilation system for any cargo handling space must change all the air in that space and its adjoining trunks at least 30 times each hour.

(d) Each ventilation system for gas-safe cargo control station must be one that can change all the air in that space at least eight times each hour.

(e) A ventilation system must not recycle vapor from ventilation discharges.

(f) Each ventilation system must have operation controls outside the ventilated space.

(g) No ventilation duct for a gas-dangerous space may pass through any machinery, accommodation, service, or control space, except as allowed under § 154.703.

(h) Each electric motor that drives a ventilation fan must be outside ducts for any space that may contain flammable cargo vapors.

(i) Ventilation impellers and the housing in way of these impellers on flammable cargo carrier must meet one of the following:

(1) The impeller, housing, or both must be made of non-metallic material that does not generate static electricity.

(2) The impeller and housing must be made of non-ferrous material.

(3) The impeller and housing must be made of austenitic stainless steel.

(4) The impeller and housing must be made of ferrous material and have at least 13mm (.512 in.) of tip clearance.

(j) No ventilation fan may have any combination of fixed or rotating components made of an aluminum or magnesium alloy and ferrous fixed or rotating components.

(k) Each ventilation intake and exhaust must have a protective metal screen of not more than 13mm (.512 in.) square mesh.

§ 154.1210 Hold space, void space, cofferdam, and space that contains cargo piping.

(a) Each hold space, void space, cofferdam, and space that contains cargo piping must have—

(1) A fixed mechanical ventilation system; or

(2) A fixed ducting system that has a portable blower that meets § 154.1205(i) and (j).

(b) A portable blower in any personnel access opening must not reduce the area of that opening so that the opening does not meet § 154.308.

INSTRUMENTATION

§ 154.1300 Liquid level gauges: General.

(a) If Table 4 lists a closed gauge for a cargo, the liquid level gauges required by § 154.1305 must be closed gauges that do not have any opening through which cargo liquid or vapor could escape, such as an ultrasonic device, float type device, electronic or magnetic probe, or bubble tube indicator.

(b) If Table 4 lists a restricted gauge for a cargo, the liquid level gauges required by § 154.1305 must be closed gauges that meet paragraph (a) of this section or restricted gauges that do not vent the tank's vapor space, such as a fixed tube, slip tube, or rotary tube.

§ 154.1305 Liquid level gauges: Standards.

(a) Each tank must have at least one liquid level gauge that operates—

(1) At pressures that are equal to or greater than the MARVS of that tank; and

(2) At temperatures that are within the cargo handling temperature range for all cargoes carried.

(b) Each tank must have at least two liquid level gauges, unless the tank has one liquid level gauge that can be repaired and maintained while the tank contains cargo.

(c) Each required liquid level gauge must measure liquid levels from 100 mm (4 in.) or less of the tank bottom to 100 percent full.

§ 154.1310 Closed gauge shutoff valve.

Each closed gauge that is not mounted directly on the tank must have a shutoff valve that is as close as practicable to the tank.

§ 154.1315 Restricted gauge excess flow valve.

Each restricted gauge that penetrates a tank must have an excess flow valve, unless the gauge has no opening greater than 1.5 mm (.059 in.) in diameter through which liquid or vapor can escape.

§ 154.1320 Sighting ports, tubular gauge glasses, and flat plate type gauge glasses.

(a) Tanks may have sighting ports or a secondary means of liquid level gauging in addition to the gauges required under § 154.1305 if —

(1) The tank has a MARVS that is less than 0.7 kp/cm^2 (10 psig);

(2) The port has a protective cover and an internal scale; and

(3) The port is above the liquid level.

(b) Tubular gauge glasses must not be used as liquid level gauges for tanks.

(c) The plate type gauge glasses must not be used as liquid level gauges for tanks, except deck tanks if the glasses have excess flow valves.

§ 154.1325 Liquid level alarm: All tanks.

Except as allowed under § 154.1330, each cargo tank must have a high liquid level alarm that—

(a) Is independent of the liquid level gauge required under § 154.1305;

(b) Actuates an audible and visual alarm at the cargo control station before the liquid level in the tank reaches the maximum filling limit allowed under § 154.1844; and

(c) Actuates the quick closing valves required under §§ 154.530, 154.532, and 154.538 before the tank becomes liquid full and without causing the pressure in the loading lines to exceed the design pressure.

§ 154.1330 Liquid level alarm: Independent tank type C.

Independent tank type C need not have the high liquid level alarm required under § 154.1325 if—

(a) The tank volume is less than 200 m³ (17,060 ft.³); or

(b) The tank can withstand the maximum possible pressures during loading, that pressure is below the relief valve setting, and overflow of the tank cannot occur.

§ 154.1335 Pressure and vacuum gauge.

(a) The vapor space of each tank must have a pressure gauge and, if vacuum protection is required under § 154.804, a vacuum gauge that—

(1) Can be read at the tank; and

(2) Have the remote readouts at the cargo control station.

(b) The vessel must have at least one high pressure alarm that—

(1) Actuates before the pressure in any tank exceeds the maximum pressure specially approved by the Commandant (G–MMT); and

(2) Actuates an audible and visual alarm in the wheelhouse and at the cargo control station.

(c) If vacuum protection is required under § 154.804, each vessel must have at least one low pressure alarm that—

(1) Actuates before the pressure in any tank falls below the minimum pressure specially approved by the Commandant (G–MMT); and

(2) Actuates an audible and visual alarm in the wheelhouse and the cargo control station.

(d) At least one pressure gauge must be fitted on each—

(1) Enclosed hold;

(2) Enclosed interbarrier space;

(3) Cargo pump discharge line;

(4) Liquid cargo manifold; and

(5) Vapor cargo manifold.

(e) There must be a local manifold presssure gauge between each manifold stop valve and each hose connection to the shore.

§ 154.1340 Temperature measuring devices.

(a) Each tank must have at least two devices that measure the temperature—

(1) At the bottom of the tank; and

(2) Near the top of the tank and below the maximum liquid level allowed under § 154.1844.

(b) Each device required by paragraph (a) must have a read-out at the cargo control station.

(c) Except independent tanks type C, each cargo containment system that carries cargo at temperatures colder than –55° C (—67° F) must have temperature measuring devices as follows:

(1) the number and location of the devices must be specially approved by the Commandant (G–MMT).

(2) The devices must be within the tank's insulation or on the adjacent hull structure.

(3) Each device must show the temperature continuously or at regular intervals of one hour or less.

(4) Each device must actuate an audible and visual alarm at the cargo control station before the temperature of the steel of the adjacent hull structure goes below the lowest temperature allowed for the steel under § 154.172.

(d) Each tank that carries cargo at temperatures colder than –55° C (–67° F) must have the number and arrangement of the devices that show the temperature of the tank during cool down procedures specially approved by the Commandant (G–MMT).

(e) One tank on the first vessel of a class of vessels must have in addition to the devices required by paragraph (d) of this section, devices that show the temperature of the boundary for verification of the cool down procedure.

§ 154.1345 Gas detection.

(a) For a vessel that carries a cargo that has an "I" or "I and T" in Table 4, the vessel must have—

(1) A fixed flammable gas detection system that meets § 154.1350; and

(2) Two portable gas detectors that can each measure 0 to 100 percent of the lower flammable limit of the cargo carried.

(b) For a vessel that carries a cargo that has a "T" or "I and T" in Table 4, the vessel must have—

(1) Two portable gas detectors that show if the concentration of cargo is above or below the threshold limit value listed in 29 CFR Part 1910 for that cargo; and

(2) Fixed gas sampling tubes in each hold space and interbarrier space as follows:

(i) The number of tubes must be specially approved by the Commandant (G–MMT).

(ii) Each tube must be valved and caped above the main deck unless it is connected to a fixed toxic gas detector.

(iii) If the vessel carries cargo that is heavier than the atmosphere of the space, each tube must have its open and in the lower part of the space.

(iv) If the vessel carries cargo that is lighter than the atmosphere of the space, each tube must have its open end in the upper part of the space.

(v) If the vessel carries cargo that is heavier than the atmosphere of the space and cargo that is lighter than the atmosphere of the space, each space must have tubes with their open ends in the lower part of the space and tubes with their open ends in the upper part of the space.

(vi) If the vessel carries cargo that can be both heavier and lighter than the atmosphere of the space, each space must have tubes with their open ends in the lower part of the space and tubes with their open ends in the upper part of the space.

(c) A vessel that carries methyl bromide or sulphur dioxide must have a fixed gas detection system that meets § 154.1350, except paragraph (i), and be in a gas safe cargo control station.

(d) Each alarm required by § 154.1350(d) on a vessel that carries methyl bromide and sulphur dioxide must be set or below the threshold limit value listed in 29 CFR Part 1910 for the cargo carried.

§ 154.1350 Flammable gas detection system.

(a) The vessel must have a fixed flammable gas detection system that has sampling points in—

(1) Each cargo pump room;

(2) Each cargo compressor room;

(3) Each motor room for cargo handling machinery;

(4) Each cargo control station that is not gas-safe;

(5) Each hold space, interbarrier space, and other enclosed space in the cargo area if the vessel has tanks other than independent tanks Type C; and

(6) Each space between the doors of an air lock required under § 154.345.

(b) The sampling points required under paragraph (a) of this section must meet § 154.1345(b)(2)(iii) through (vi).

(c) Gas sampling lines for the flammable gas detection system must not pass through any gas safe spaces, except gas safe cargo control rooms.

(d) Each flammable gas detection system must have audible and visual alarms that are actuated before or when the cargo is at a concentration that is equivalent to 30 percent of the lower flammable limit in air of the cargo carried.

(e) The visual alarm required by paragraph (d) of this section that is at a gas detector readout location must visually identify the space in which there is an alarm condition.

(f) Each flammable gas detection system must have an audible and a visual alarm for power failure and loss of gas sampling flow.

(g) Audible and visual alarms required under paragraphs (d) and (f) of this section must be—

(1) In each wheelhouse;

(2) In each cargo control station; and

(3) At each gas detection readout location.

(h) Each flammable gas detection system must monitor each sampling point at 30 minute or shorter intervals.

(i) All electrical equipment for each flammable gas detection system that is in a gas dangerous space or area must meet §§ 154.1000 through 154.1015.

(j) Each flammable gas detection system must have enough flame arrestors to protect all gas sampling lines.

(k) Each flammable gas detection system must have a filter that removes particulate matter in each gas sampling line.

(l) Each filter required by paragraph (k) of this section must be where it is removable during vessel operation unless it can be freed by back pressure.

(m) Each flammable gas detection system in a gas-safe cargo control station or wheelhouse must—

(1) Have a shut-off valve in each sampling line from an enclosed space, such as a hold or interbarrier space; and

(2) Exhaust gas to a safe location in the open atmosphere and away from all ignition sources.

(n) Each flammable gas detection system must not have common sampling lines, except sampling lines may be manifolded at the gas detector location if each line has an automatic valve that prevents cross-communication between sampling points.

(o) [Reserved]

(p) Each flammable gas detection system must have at least one connection for injecting zero gas and span gas into the system for testing and calibration.

(q) Each flammable gas detection system must have span gas for testing and calibration that is a known concentration of the cargo carried or the span gas recommended by the manufacturer of the flammable gas analyzer.

(r) The calibration test procedure and recommendation for type and concentration of span gas of the manufacturer of the flammable gas analyzer for each flammable gas detection system must be posted on or in the gas analyzer cabinet.

(s) Each flammable gas detection system must have a flow meter in each gas sampling line.

(t) Each flammable gas detection system must measure concentrations of 0 to 100 percent of the lower flammable limit of the cargo carried.

(u) In each hold and each interbarrier space that contains tanks other than independent tanks Type A, B, or C, the flammable gas detection system must measure concentrations of 0 to 100 percent by volume of the cargo carried by—

(1) An analyzer other than the one required under paragraph (t) of this section; or

(2) The analyzer required by paragraph (t) of this section with a scale switch that automatically returns the analyzer to 0 to 100 percent of the lower flammable limit scale when released.

§ 154.1360 Oxygen analyzer.

The vessel must have a portable analyzer that measures oxygen levels of 10 to 20 percent by volume in an inert atmosphere.

§ 154.1365 Audible and visual alarms.

(a) Each audible alarm must be one that can be turned off after sounding an alarm.

(b) Each visual alarm must be one that only can be turned off after the fault that actuated it is cleared.

(c) Each visual alarm must be marked to show the type and location of each fault that can actuate it.

(d) Each vessel must have means for testing each alarm.

§ 154.1370 Pressure gauge and vacuum gauge marking.

Each pressure gauge and vacuum gauge required by § 154.1335(a) must be marked with the maximum and minimum pressures that are specified on the vessel's certificate for the cargo carried.

§ 154.1375 Read-out for temperature measuring device marking.

Each read-out required by § 154.1340 for a device that measures temperature in a tank must be marked with the lowest temperature specified for the tank on the vessel's certificate.

SAFETY EQUIPMENT

§ 154.1400 Safety equipment: All vessels.

(a) A vessel of less than 25,000 m^3 cargo capacity must have the following personnel safety equipment:

(1) Six self-contained air-breathing apparatus each having a capacity of at least 1200 liters (42.36 ft^3).

(2) Nine spare bottles of air for the self-contained air-breathing apparatus on board.

(3) Six steel-cored lifelines.

(4) Six three-cell, explosive proof flashlights with the Underwriters' Laboratories, Inc., label for Class I Division I and the Group listed in Table 4 for the cargoes carried.

(5) Three fire axes.

(6) Six helmets that meet the specifications of ANSI Safety Requirements for Industrial Head Protection, Z–89.1 (1969).

(7) Six sets of boots and gloves that are made of rubber or other electrically non-conductive material.

(8) Six sets of goggles that meet the specifications of ANSI Practice for Occupational and Educational Eye and Face Protection, Z–87.1 (1968).

(9) Three outfits that protect the skin from scalding steam and the heat of fire, and that have a water resistant outer surface.

(10) Three chemical protective outfits.

(b) A vessel of 25,000 m^3 cargo capacity or more must have the following personnel safety equipment:

(1) Eight self-contained air-breathing apparatus that each have a capacity of at least 1200 liters (42.36 ft^3).

(2) Nine spare bottles of air for the self-contained air-breathing apparatus on board.

(3) Eight steel-cored lifelines.

(4) Eight three-cell, explosive proof flashlights with the Underwriters' Laboratories, Inc., label for the Group listed in Table 4 for the cargoes carried.

(5) Five fire axes.

(6) Eight helmets that meet the specifications of ANSI Safety Requirements for Industrial Head Protection, Z–89.1 (1969).

(7) Eight sets of boots and gloves that are made of rubber or other electrically non-conductive material.

(8) Eight sets of goggles that meet the specifications of ANSI Practice for Occupational and Educational Eye and Face Protection, Z–87.1 (1968).

(9) Five outfits that protect the skin from scalding steam and the heat of fire, and that have a water resistant outer surface.

(10) Three chemical protective outfits.

(c) When Table 4 references this section, a vessel carrying the referenced cargo must have the following additional personnel protection equipment:

(1) Three self-contained air-breathing apparatus that each have a capacity of at least 1200 liters (42.36 ft^3).

(2) Nine spare bottles of air for the self-contained air-breathing apparatus on board.

(3) Three steel-cored lifelines.

(4) Three three-cell, explosive proof flashlights with the Underwriters' Laboratories, Inc., label for the Group listed in Table 4 for the cargoes carried.

(5) Three helmets that meet the specifications of ANSI Safety Requirements for Industrial Head Protection, Z–89.1 (1969).

(6) Three sets of boots and gloves that are made of other electrically non-conductive material.

(7) Three sets of goggles that meet the specifications of ANSI Practice for Occupational and Educational Eye and Face Protection, Z–87.1 (1968).

(8) Three chemical protective outfits.

§ 154.1405 Respiratory protection.

When Table 4 references this section, a vessel carrying the referenced cargo must have—

(a) Respiratory protection equipment for the cargoes carried for every person on board; and

(b) Two additional sets of respiratory protection equipment for the cargoes stowed in the wheelhouse.

§ 154.1410 Decontamination shower.

When Table 4 references this section, a vessel carrying the referenced cargo must have a decontamination shower and an eye wash that are—

(a) On the weatherdeck; and

(b) Marked EMERGENCY SHOWER in letters—

(1) 7.6 cm (3 in.) high; and

(2) 5.1 cm (2 in.) wide.

§ 154.1415 Air compressor.

A vessel must have an air compressor to recharge the bottles for breathing apparatus.

§ 154.1420 Stretchers and equipment.

A vessel must have—

(a) Two stretchers or wire baskets; and

(b) Equipment for lifting an injured person from a cargo tank, hold, or void space.

§ 154.1425 Oxygen resuscitation.

A vessel must have an oxygen resuscitator.

§ 154.1430 Equipment locker.

One of each item listed in §§ 154.1400 and 154.1420 must be stowed in a marked locker—

(a) On the open deck in or adjacent to the cargo area; or

(b) In the accommodation house near to a door opening onto the main deck.

§ 154.1435 Medical first aid guide.

Each vessel must have a copy of the IMCO Medical First Aid Guide for Use in Accidents Involving Dangerous Goods.

§ 154.1440 Antidotes.

A vessel must have the antidotes prescribed in the IMCO Medical First Aid

Guide for Use in Accidents Involving Dangerous Goods for the cargoes being carried.

§ 154.1445 Lifesaving devices.

The design of the lifeboats and liferafts must allow for launching at the final angle of heel from the lower side of the vessel.

Subpart D—Special Requirements

§ 154.1700 Materials of construction.

When Table 4 references one of the following paragraphs in this section, the materials in the referenced paragraph must not be used in components that contact the cargo liquid or vapor:

(a) Aluminum and aluminum bearing alloys.

(b) Copper and copper bearing alloys.

(c) Zinc or galvanized steel.

(d) Magnesium.

(e) Mercury.

(f) Acetylide forming materials, such as copper, silver, and mercury.

§ 154.1705 Independent tank type C.

The following cargoes must be carried in an independent tank type C that meets § 154.701(a)(2):

(a) Ethylene oxide.

(b) Methyl bromide.

(c) Sulphur dioxide.

§ 154.1710 Exclusion of air from cargo tank vapor spaces.

When a vessel is carrying acetaldehyde, butadiene, ethylene oxide, or vinyl chloride, air must be—

(a) Purged from the cargo tanks and associated piping before the cargo is loaded; and

(b) Excluded after the cargo is loaded by maintaining a positive pressure of at least 0.14 kp/cm² (2 psig) by—

(1) Introducing a gas that—

(i) Is not reactive;

(ii) Is not flammable; and

(iii) Does not contain more than 0.2 percent oxygen by volume; or

(2) Controlling the cargo temperature.

§ 154.1715 Moisture control.

When a vessel is carrying sulphur dioxide, the master shall ensure that—

(a) A cargo tank is dry before it is loaded with sulphur dioxide; and

(b) Air or inert gas admitted into a tank carrying sulphur dioxide during discharging or tank breathing has a moisture content equal to or less than the moisture content of air with a dewpoint of −45° C (−49° F) at atmospheric pressure.

§ 154.1720 Indirect refrigeration.

A refrigeration system that is used to cool acetaldehyde, ethylene oxide, or methyl bromide, must be an indirect refrigeration system that does not use vapor compression.

§ 154.1725 Ethylene oxide.

(a) A vessel carrying ethylene oxide must—

(1) Have cargo piping, vent piping, and refrigeration equipment that have no connections to other systems;

(2) Have valves, flanges, fittings, and accessory equipment made of steel, stainless steel, except types 416 and 442, or other material specially approved by the Commandant (G-MHM);

(3) Have valve disk faces, and other wearing parts of valves made of stainless steel containing not less than 11 percent chromium;

(4) Have gaskets constructed of spirally wound stainless steel with teflon or other material specially approved by the Commandant (G-MHM);

(5) Not have asbestos, rubber, or cast iron components in the cargo containment system and piping; and

(6) Not have threaded joints in cargo piping.

(b) Cargo hose used for ethylene oxide must—

(1) Be specially approved by the Commandant (G-MMT); and

(2) Be marked "For (Alkylene or Ethylene) Oxide Transfer Only."

(c) Ethylene oxide must be maintained at less than 30° C (88° F).

(d) Cargo tank relief valves for tanks containing ethylene oxide must be set at 5.5 kp/cm² (78.2 psig) or higher.

(e) A vessel must have a method specially approved by the Commandant (G-MHM) of jettisoning ethylene oxide.

§ 154.1730 Ethylene oxide: Loading and off loading.

(a) The master shall ensure that before ethylene oxide is loaded into a tank—

(1) The tank is thoroughly clean, dry, and free of rust; and

(2) The tank vapor spaces and hold spaces are inerted with an inert gas that meets § 154.1710(b)(1).

(b) Ethylene oxide must be off loaded by a deepwell pump or inert gas displacement.

(c) Ethylene oxide must not be carried in deck tanks.

§ 154.1735 Methyl acetylene-propadiene mixture.

(a) The composition of the methyl acetylene-propadiene mixture at loading must be within the following limits:

(1) Maximum methyl acetylene and propadiene molar ratio of 3 to 1.

(2) Maximum combined concentration of methyl acetylene and propadiene of 65 mole percent.

(3) Minimum combined concentration of propane, butane, and isobutane is 24 mole percent, of which at least one third must be butanes and one third propane.

(4) Maximum propylene concentration of 10 mole percent.

(5) Maximum butadiene concentration of 2 mole percent.

(b) A vessel carrying a methyl acetylene-propadiene mixture must have a refrigeration system that does not use vapor compression or a refrigeration system that has the following features:

(1) Uses vapor compression so that the temperature to which the vapor may be subjected is 60° C (140° F) or less and the pressure is 17.6 kp/cm² (250 psig) or less.

(2) Discharge piping that has—

(i) Two temperature actuated shutdown switches set to operate at 60° C (140° F) or less;

(ii) A pressure actuated shutdown switch set to operate at 17.6 kp/cm² (250 psig) or less; and

(iii) A safety relief valve set to relieve at 18.0 kp/cm² (256 psig) or less.

(3) A relief valve that vents to a mast that meets § 154.805 and does not relieve into the compressor suction line.

(4) An alarm that sounds in the cargo control station and in the wheelhouse when the high pressure switch, high temperature switch, or relief valve operates.

(c) A vessel carrying a methyl acetylene-propadiene mixture must have cargo piping, vent piping, and refrigeration equipment that have no connections to other systems.

§ 154.1740 Vinyl chloride: Inhibiting and inerting.

When a vessel is carrying vinyl chloride, the master shall ensure that—

(a) Vinyl chloride is inhibited under the requirements of § 154.1818; or

(b) The requirements in § 154.1710 are met, and the oxygen content of inert gas is less than 0.1 percent by volume.

§ 154.1745 Vinyl chloride: Transferring operations.

A vessel carrying vinyl chloride must meet the requirements under § 40.15-1 of this chapter.

§ 154.1750 Butadiene or vinyl chloride: Refrigeration system.

A refrigeration system for butadiene or vinyl chloride must not use vapor compression unless it—

(a) Avoids any stagnation points where uninhibited liquid can accumulate; or

(b) Has inhibited liquid from the tank added to the vapor upstream of the condenser.

§ 154.1755 Nitrogen.

Cargo containment systems other than deck tanks on vessels carrying nitrogen must be specially approved by the Commandant (G-MMT).

Subpart E—Operations

§ 154.1800 Special operating requirements under Part 35 of this chapter.

A vessel must meet the requirements of Part 35 of this chapter.

§ 154.1802 Certificates, letters, and endorsements required.

(a) No person may operate a U.S. flag vessel unless the vessel's Certificate of Inspection issued under Subchapter D of this chapter is endorsed with the name of the cargo that it is allowed to carry.

(b) No person may operate a foreign flag vessel on the navigable waters of the United States unless the vessel has—

(1) A Certificate of Fitness for Carriage of Liquefied Gases in Bulk issued by the country of registry and a Letter of Compliance issued by the Commandant (G-MHM) endorsed under this part with the name of the cargo that it is allowed to carry; or

(2) A Letter of Compliance issued by the Commandant (G-MHM) endorsed with the name of the cargo that it is allowed to carry.

(3) The following plans and information are carried aboard:

(i) A description and schematic plan of the arrangement for inerting cargo tanks, hold spaces, and interbarrier spaces.

(ii) A description of the tank gauging equipment.

(iii) A description and instruction manual for the calibration of the cargo leak detector equipment.

(iv) A schematic plan that shows the locations of leak detectors and sampling points.

(v) A description of the systems for cargo temperature and pressure control for methane to meet proposed §§ 154.701 through 154.709.

§ 154.1804 Document posted in wheelhouse.

No person may operate a vessel unless the endorsed document required under § 154.1802 is under glass in the wheelhouse.

§ 154.1806 Copy of this subchapter on board.

No person may operate a U.S. flag vessel unless a copy of this part and a copy of Part 35 of this chapter are on board.

§ 154.1808 Limitations in the endorsement.

No person may operate a vessel unless that person complies with all limitations in the endorsement on the vessel's Certificate of Inspection or Letter of Compliance.

§ 154.1809 Loading and stability manual.

(a) No person may operate a vessel unless the vessel has on board a loading and stability manual.

(b) The loading and stability manual must contain—

(1) Information that enables the master to load and ballast the vessel while keeping structural stresses within design limits and positive metacentric height;

(2) Damage stability information, including all loading restrictions; and

(3) Trim information.

§ 154.1810 Cargo manual.

(a) No person may operate a vessel unless the vessel has on board a cargo manual.

(b) The cargo manual must contain the following information:

(1) A description of each cargo and its handling hazards as a liquid and as a gas, including accidents involving frostbite and asphyxiation, safety equipment, and first aid measures.

(2) A description of the dangers of asphyxiation from the inerting gases used on the vessel.

(3) The measures necessary to mitigate embrittlement of steel structure in way of cargo leakage.

(4) The use of the firefighting systems on the vessel.

(5) The features of the cargo containment system that effect operation and maintenance, including pressure and temperature ranges and relief valve setting.

(6) Pressures, temperatures, and liquid levels for all operations.

(7) General information derived from the first loading of the vessel.

(8) All alarm settings.

(9) A description of the components of the cargo system, including the following:

(i) Liquid cargo system.

(ii) Liquid recirculating or condensate return system.

(iii) Cargo tank cool-down system.

(iv) Cargo tank warm-up or vaporization system.

(v) Gas main system.

(vi) Cargo tank or compressor relief system and blocked liquid or gas relief system.

(vii) Inerting system.

(viii) Boil-off gas compressor or reliquefaction system.

(ix) Vapor leak detection systems.

(x) Alarm or safety indication systems.

(xi) Cargo jettisoning system.

(xii) Gas or fuel to engine room system.

(10) A description of cargo loading and discharge operations, including simultaneous handling of multigrades of cargo and ballast.

(11) A description of cargo operations during the voyage.

(12) A description of cargo tank cool-down and warm-up operations including purging and gasfreeing.

(13) A description of hull and cargo tank temperature monitoring systems.

(14) A description of vapor leak detection and alarm or safety systems.

(15) A description of the following conditions and their symptoms, including emergency measures and corrective actions:

(i) Cargo or ballast valve malfunction.

(ii) Low cargo tank gas pressure.

(iii) High fill level shutdown.

(iv) Gas compressor shutdown.

(v) Hull cold spots.

(vi) Cargo piping leaks.

(vii) Primary or secondary barrier failure.

(viii) Hold boundary structural failure.

(ix) Fire in vent mast head.

(x) Reliquefaction plant failure.

(xi) Vaporizer malfunction or failure.

(xii) Piping or cargo valve freeze-up.

(16) Any other matters relating to operation of the cargo systems.

(17) Operational means necessary to maintain the vessel in a condition of positive stability through all conditions of—

(i) loading and deballasting; and

(ii) unloading and ballasting.

(c) The master shall ensure that the cargo manual is kept up-to-date.

§ 154.1812 Operational limitation information.

The master shall ensure that terminal personnel are told the operational limitation information required by § 154.1810 (b) (17).

§ 154.1814 Cargo information cards.

(a) No person may operate a vessel unless a cargo information card for each cargo being transported is carried either in the wheelhouse, in the ship's office, or in another location easily accessible to the person in charge of the watch.

(b) When a vessel is moored at a terminal, the master shall ensure that a set of information cards is in the possession of the terminal's person in charge of cargo transfer operations.

(c) Each card must be at least 17 cm x 24 cm (7 in. x 9½ in.), have printing on one side only, and must contain the following information about the cargo:

(1) Name as listed in Table 4.

(2) Appearance.

(3) Odor.

(4) The hazards involved in handling procedures for safe handling, including any special handling instructions.

(5) Procedures to follow in the event of spills, leaks, equipment breakdown, or uncontrolled cargo release.

(6) Procedures to be followed if a person is exposed to the cargo.

(7) Firefighting procedures and media.

§ 154.1816 Cargo location plan.

The master shall ensure that—

(a) A cargo location plan is prepared that gives—

(1) The location and number of each cargo tank; and

(2) The name of the cargo in each tank;

(b) One cargo location plan is kept with the sets of cargo information cards required under § 154.1814; and

(c) The cargo names in the cargo location plan do not differ from the names of the cargoes listed in Table 4.

§ 154.1818 Certificate of inhibition.

(a) Except as provided in § 154.1740 (b), no person may operate a vessel carrying butadiene or vinyl chloride without carrying in the wheelhouse written certification from the shipper that the product is inhibited.

(b) The certification required by this section must contain the following information:

(1) The name and concentration of the inhibitor.

(2) The date the inhibitor was added.

(3) The expected duration of the inhibitor's effectiveness.

(4) Any temperature limitations qualifying the inhibitor's effective lifetime.

(5) The action to be taken if the time of the voyage exceeds the inhibitor's lifetime.

§ 154.1820 Shipping document.

No person may operate a vessel without carrying a shipping document in the wheelhouse that lists for each cargo on board—

(a) The tank in which the cargo is stowed;

(b) The name of the shipper;

(c) The location of the loading terminal;

(d) The cargo name as listed in Table 4; and

(e) The approximate quantity of the cargo.

§ 154.1822 Shipping document: Copy furnished the transfer terminal.

While a vessel is moored at a transfer terminal, the master shall ensure that at least one copy of the shipping document is given to the terminal's person in charge of cargo transfer.

§ 154.1824 Obstruction of pumproom ladderways.

The master shall ensure that each cargo pumproom access is unobstructed.

§ 154.1826 Opening of tanks and cargo sampling.

(a) The master shall ensure that each tank opening is fully closed at all times.

(b) The master may authorize the opening of a tank—

(1) During tank cleaning; and

(2) To sample a cargo that Table 4 allows to be carried in a containment system having a restricted gauging system if—

(i) The tank is not being filled during sampling;

(ii) The vent system has relieved any pressure in the tank; and

(iii) The person sampling the cargo wears the protective clothing required under § 154.1840.

(c) The master shall ensure that cargoes requiring closed gauging as listed in Table 4 are sampled only through the controlled sampling arrangement of the tank.

§ 154.1828 Spaces containing cargo vapor: Entry.

(a) No person may enter a cargo handling space without the permission of the master.

(b) Before allowing anyone to enter a cargo handling space, the master shall ensure that—

(1) The space is free of toxic vapors and has enough oxygen to support life; or

(2) Those entering the space wear protective equipment with breathing apparatus and an officer closely supervises the entire operation.

§ 154.1830 Warning sign.

(a) The master shall ensure that a vessel transferring cargo while fast to a dock or while at anchor in port, displays a warning sign—

(1) At the gangway facing the shore so that the sign may be seen from the shore; and

(2) Facing outboard towards the water so that the sign may be seen from the water.

(b) Except as provided in paragraph (f) of this section, each warning sign must have the following legends:

(1) Warning.

(2) Dangerous Cargo.

(3) No Visitors.

(4) No Smoking.

(5) No Open Lights.

(c) Each letter on the sign must—

(1) Be block style;

(2) Be black on a white background;

(3) Be 7.6 cm (3 in.) high;

(4) Be 5.1 cm (2 in.) wide, except for "M" and "W" which must be 7.6 cm (3 in.) wide, and the letter "I" which may be 1.3 cm (½ in.) wide; and

(5) Have 1.3 cm (½ in.) stroke width.

(d) The spacing between letters must be—

(1) 1.3 cm (½ in.) between letters on the sign of the same word;

(2) 5.1 cm (2 in.) between words;

(3) 5.1 cm (2 in.) between lines; and

(4) 5.1 cm (2 in.) at the borders of the sign.

(e) The legends "No Smoking" and "No Open Lights" are not required when the cargoes on board a vessel are not flammable.

§ 154.1832 Incompatible cargo.

(a) The person in charge of cargo transfer may not authorize the loading of incompatible[7] cargoes into cargo containment systems unless the cargo containment systems are separated by—

(1) Cofferdams, other than the spaces between primary and secondary barriers;

(2) Empty tanks;

(3) Tanks containing mutually compatible cargo; or

(4) Piping tunnels.

(b) The person in charge of cargo transfer may not authorize loading of incompatible[7] cargoes into cargo containment systems that have common piping or venting systems.

(c) The person in charge of cargo transfer may not authorize loading of a cargo that is incompatible[7] with residue left in a tank from a previous cargo.

§ 154.1834 Cargo transfer piping.

The person in charge of cargo transfer shall ensure that cargo is transferred to or from a tank only through the cargo piping system.

§ 154.1836 Venting.

The person in charge of cargo transfer shall ensure that no cargo vapor is vented into the atmosphere.

§ 154.1838 Discharge by gas pressurization.

The person in charge of cargo transfer may not authorize cargo discharge by gas pressurization unless—

(a) The tank to be offloaded is an independent tank type B or C;

(b) The pressurizing medium is either the cargo vapor or a nonflammable, nontoxic gas that is inert with the cargo; and

(c) The pressurizing line has—

(1) A pressure reducing valve that has a setting that is 90 percent or less of the tank's MARVS; and

(2) A manual control valve between the pressure reducing valve and the tank.

[7] Incompatible cargoes are listed in Navigation and Vessel Inspection Circular 4-75 and is available from the Commandant (G-MHM-3/83) U.S. Coast Guard, Washington, D.C. 20590.

§ 154.1840 Protective clothing.

The person in charge of cargo transfer shall ensure that every person involved in cargo transfer wears the protective clothing, boots, gloves, and goggles required under § 154.1400.

§ 154.1842 Cargo systems controls and alarms.

The master shall ensure that each cargo emergency shutdown and alarm system used in cargo transfer is tested before cargo transfer begins.

§ 154.1844 Cargo tanks: Filling limits.

(a) The master shall ensure that a cargo tank is not loaded—

(1) More than 98 percent full; or

(2) In excess of the volume determined under the following formula, unless a higher limit is specified on the Certificate:

$$V_L = 0.98\,V\,\frac{d_r}{d_L}$$

where:

V_L = Maximum volume to which the tank may be loaded.

V = Volume of the tank.

d_r = Density at the reference temperature specified in (b).

d_L = Density of the cargo at the loading temperature and pressure.

(b) The reference temperature to be used in paragraph (a) of this section is the temperature corresponding to the vapor pressure of the cargo at the set pressure of the pressure relief valves.

§ 154.1846 Relief valves: Changing set pressure.

The master shall—

(a) Supervise the changing of the set pressure of relief valves under the requirements of § 154.802(b);

(b) Enter the change of set pressure in the vessel's log; and

(c) Ensure that a sign showing the set pressure is posted—

(1) In the cargo control room or station; and

(2) At each relief valve.

§ 154.1848 Inerting.

(a) A master shall ensure that—

(1) Hold and interbarrier spaces on vessels with full secondary barriers are inerted when flammable cargoes are carried;

(2) Hold and interbarrier spaces are maintained full of dry air or inerted gas on—

(i) Vessels with partial secondary barriers;

(ii) Vessels with full secondary barriers when non-flammable cargoes are carried; and

(iii) Vessels with refrigerated independent tanks type C;

(3) When tanks containing flammable vapor are to be gas freed, the flammable vapors are purged from the tank by inert gas before air is admitted; and

(4) When gas free tanks are to be filled with a flammable cargo, air is purged from the tank by inert gas before cargo liquid or vapor is introduced.

(b) Inert gas must be supplied from the shore or from the vessel's inert gas system.

§ 154.1850 Entering cargo handling spaces.

(a) The master shall ensure that the ventilation system required under § 154.-1205 is in operation for 30 minutes before a person enters one of the following:

(1) Spaces containing cargo pumps, compressors, and compressor motors.

(2) Gas dangerous cargo control spaces.

(3) Other spaces containing cargo handling equipment.

(b) The master shall ensure that a warning sign is posted outside of each space listed in paragraph (a) of this section which sets out the requirement for use of the ventilation system.

(c) The master shall ensure that no sources of ignition are put in a cargo handling space on a vessel carrying flammable cargo unless the space is gas free.

§ 154.1852 Air breathing equipment.

(a) The master shall ensure that a licensed officer inspects the compressed air breathing equipment at least once each month.

(b) The master shall enter in the vessel's log a record of the inspection required under paragraph (a) of this section that includes—

(1) The date of the inspection; and

(2) The condition of the equipment at the time of the inspection.

§ 154.1854 Methane (LNG) as fuel.

(a) If methane (LNG) vapors are used as fuel in the main propulsion system of a vessel, the master shall ensure that the pilot fuel oil burner required under § 154.703(c)(7) is used when the vessel is on the navigable waters of the United States.

(b) When the methane (LNG) fuel supply is shut down due to loss of ventilation or detection of gas, the master shall ensure that the methane (LNG) fuel supply is not used until the leak or other cause of the shutdown is found and corrected.

(c) The master shall ensure that the requirements in paragraph (b) of this section are posed in the main machinery space.

§ 154.1856 Correction of cold spots in the hull.

No person may operate a vessel unless cold spots in the hull are corrected under the requirements of § 154.122.

§ 154.1858 Cargo hose used in prototype testing.

The master shall ensure that a cargo hose used in prototype testing is not used for cargo transfer service.

§ 154.1860 Integral tanks: Cargo colder than −10°C(14°F).

The master shall ensure that no integral tank is used to carry a cargo colder than −10° C (14° F) unless specially approved by the Commandant (G-MMT).

§ 154.1862 Posting of speed reduction.

If a speed reduction is specially approved by the Commandant under § 154.-409, the master shall ensure that the speed reduction is posted in the wheelhouse.

§ 154.1864 Vessel speed within speed reduction.

The master shall ensure that the speed of the vessel is not greater than the posted speed reduction.

§ 154.1866 Cargo hose connection: Transferring cargo.

No person may transfer cargo through a cargo hose connection unless the connection has a remotely controlled quick closing shut-off valve.

§ 154.1868 Portable blowers in personnel access openings.

The master shall ensure that a portable blower in a personnel access opening does not reduce the area of the opening so that it does not meet § 154.308.

§ 154.1870 Bow and stern loading.

(a) The master shall lock closed shut-off valves required under § 154.355(a)(3) when the bow or stern loading piping is not in use.

(b) The person in charge of cargo transfer shall ensure that after the bow or stern loading piping is used it is purged of cargo vapors with inert gas.

(c) The person in charge of cargo transfer shall ensure that entrances, forced or natural ventilation intakes, exhausts, and other openings to any deck house alongside the bow or stern loading piping are closed when this piping is in use.

(d) The person in charge of cargo transfer shall ensure that bow or stern loading piping installed in the area of the accommodation, service, or control space is not used for the following:

(1) Acetaldehyde.

(2) Ammonia, anhydrous.

(3) Dimethylamine.

(4) Ethylamine.

(5) Methyl Chloride.

(6) Vinyl Chloride.

TABLE 4.—*Summary of minimum requirements*

Cargo name	Ship type	Independent tank type C required	Control of cargo tank vapor space	Vapor detection	Gaging	Electrical hazard group and class	Special requirements
Acetaldehyde	IIG/IIPG	----------	Inert	I. & T.	C	I-C	154.1400(c), 154.1410; 154.1710; 154.1720; 154.1870.
Ammonia, anhydrous	IIG/IIPG	----------	----------	T	C	I-D	154.1000, 154.1400(c); 154.1405, 154.1410; 154.1700(b)(c)(e), 154.1870.
Butadiene	IIG/IIPG	----------	Inert	I	R	I-B	154.1700(b)(d)(f), 154.1710; 154.1740, 154.1750; 154.1818.
Butane	IIG/IIPG	----------	----------	I	R	I-D	None.
Butylene	IIG/IIPG	----------	----------	I	R	I-D	Do.
Dimethylamine	IIG/IIPG	----------	----------	I. & T.	C	I-C	154.1400(c), 154.1405; 154.1410, 154.1700(b)(c)(e); 154.1870.
Ethane	IIG	----------	----------	I	R	I-D	None.
Ethylamine	IIG/IIPG	----------	----------	I. & T.	C	I-C	154.1400(c), 154.1405; 154.1410, 154.1700(b)(c)(e); 154.1870.
Ethyl chloride	IIG/IIPG	----------	----------	I. & T.	R	I-D	154.1870.
Ethylene	IIG	----------	----------	I	R	I-C	None.
Ethylene oxide	IG	Yes	Inert	I. & T.	C	I-B	154.1400(c), 154.1405; 154.1410, 154.1700(b)(d)(f); 154.705, 154.1710; 154.1720, 154.1725; 154.1730, 154.1870; 154.660(c)(2).
Methane (LNG)	IIG	----------	----------	I	C	I-D	154.703–709; 154.1854.
Methyl acetylene propadiene mix.	IIG/IIPG	----------	----------	I	R	I-	154.1735.
Methyl bromide	IG	Yes	----------	I. & T.	C	I-D	154.660(c)(2), 154.1345(c)(d), 154.1400(c); 154.1405, 154.1410; 154.1700(g), 154.1705; 154.1720, 154.1870.
Methyl chloride	IIG/IIPG	----------	----------	I. & T.	C	I-D	154.1700(a), 154.1870.
Nitrogen	IIG	----------	----------	O	C	----------	154.1755.
Propane	IIG/IIPG	----------	----------	I	R	I-D	None.
Propylene	IIG/IIPG	----------	----------	I	R	I-D	Do.
Refrigerant gases [1]	IIG	----------	----------	----------	R	----------	Do.
Sulfur dioxide	IG	Yes	Dry	T	C	----------	154.660(c)(2), 154.1345(c)(d), 154.1400(c); 154.1405, 154.1410; 154.1705, 154.1715; 154.1720, 154.1870.
Vinyl chloride	IIG/IIPG	----------	----------	I. & T.	C	I-D	154.1405, 154.1410; 154.1700(a), 154.1700(b)(d)(f), 154.1710; 154.1704, 154.1745; 154.1750, 154.1818, 154.1870.

[1] Regrigerant gases include nontoxic, nonflammable gases, such as: dichlorodifluoromethane, dichloromonofluoromethane ,dichlorotetrafluoroethane, monochlorodifluoro methane, monochlorotetrafluoroethane, monochlorotrifluoromethane.

APPENDIX A—EQUIVALENT STRESS

The Coast Guard only accepts equivalent stress (σ_e) calculated under the following or a formula specially approved by the Commandant (G–MMT) as equivalent to the following:

I.

$$\sigma_e=\sqrt{\sigma_x^2+\sigma_y^2-\sigma_x\sigma_y+3\tau_{xy}^2}$$

where:

σ_x =Total normal stress in "x" direction.

σ_y =Total normal stress in "y" direction.

τ_{xy} =Total shear stress in "xy" plane.

II. When the static and dynamic stresses are calculated separately, the total stresses in paargraph I are calculated from the following or equivalent formulae specially approved by the Commandant (G–MMT):

$$\sigma_x=\sigma_x(\text{static})\pm\sqrt{\Sigma(\sigma_x(\text{dynamic}))^2}$$

$$\sigma_y=\sigma_y(\text{static})\pm\sqrt{\Sigma(\sigma_y(\text{dynamic}))^2}$$

$$\tau_{xy}=\tau_{xy}(\text{static})\pm\sqrt{\Sigma(\tau_{xy}(\text{dynamic}))^2}$$

III. Each dynamic and static stress is determined from its acceleration component and its hull strain component from hull deflection and torsion.

APPENDIX B—STRESS ANALYSES DEFINITIONS

The following are the standard definitions of stresses for the analysis of independent tank type B:

I. "Normal stress" means the component of stress normal to the plane of reference.

II. "Membrane stress" means the component of normal stress that is uniformly distributed and equal to the average value of the stress across the thickness of the section under consideration.

III. "Bending stress" means the variable stress across the thickness of the section under consideration, after the subtraction of the membrane stress.

IV. "Shear stress" means the component of the stress acting in the plane of reference.

V. "Primary stress" means the stress produced by the imposed loading that is necessary to balance the external forces and moments. (The basic characteristic of a primary stress is that it is not self-limiting. Primary stresses that considerably exceed the yield strength results in failure or at least in gross deformations.)

VI. "Primary general membrane stress" means the primary membrane stress that is so distributed in the structure that no redistribution of load occurs as a result of yielding.

VII. "Primary local membrane stress" means the resulting stress from both a membrane stress, caused by pressure or other mechanical loading, and a primary or a discontinuity effect that produces excessive distortion in the transfer of loads to other portions of the structure. (The resulting stress is defined as a primary local membrane stress although it has some characteristics of a secondary stress. A stress region is local if—

$$S_1\leq.05\sqrt{Rt};$$

and

$$S_2\leq2.5\sqrt{Rt}$$

Where:

S_1 =distance in the meridional direction over which the equivalent stress exceeds 1.1 f.

S_2 =distance in the meridional direction to another region where the limits for primary general membrane stress are exceeded.

R =means radius of the vessel.

t =wall thickness of the vessel at the location where the primary general membrane stress limit is exceeded.

f =allowable primary general membrane stress.

VIII. "Secondary stress" means a normal stress or shear stress caused by constraints of adjacent parts or by self-constraint of a structure. (The basic characteristic of a secondary stress is that it is self-limiting. Local yielding and minor distortions can satisfy the conditions that cause the stress to occur.)

(R.S. 4472, as amended (46 U.S.C. 170); sec. 201, 86 Stat. 427, as amended (46 U.S.C. 391a); sec. 6(b)(1), 80 Stat. 937 (49 U.S.C. 1655(b)(1)); 49 CFR 1.46 (b), (t), (n)(4).)

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